PUBLIC REVIEW COMMENTS

Consolidated Public Comments for TSO-C199					
#	**Name**	**Paragraph Section**	**Comment**	**Suggested resolution**	**AIR-130 Disposition**
79	Boeing	Section 3 Para 2 page 2	The proposed text states: *"Malfunction of the function defined in paragraph 3.a of this TSO is a major failure condition. Loss of the function defined in paragraph 3.a of this TSO is a major failure condition. Design the system to at least the major failure condition classification."*	We recommend changing the text as follows: *"Malfunction of the function defined in paragraph 3.a of this TSO is a major failure condition. Loss of the function defined in paragraph 3.a of this TSO is a* ***minor*** *failure condition.* ***Misleading altitude data reported by the transponder is a major failure condition.*** *Design the system to at least the major failure condition classification."* "Malfunction of the function" can be misinterpreted and is not consistent with terminology used in AC 25.1309-1A. Instead, we recommend using the terms "loss of the function" and "misleading data." Loss of the transponder function is deemed a minor functional hazard class using the guidelines	The minor failure is a judgment on the acceptable rate of HMI for this use case. Please note that TSO-C74, the ATCRBS transponder TSO, is minor. So TSO-C199 is a consistent failure condition classification.

				and criteria of AC 25.1309-1A. Note: The functional hazard assessments (FHAs) for all of Boeing's previous and currently certified airplane models show loss of the transponder function as a minor functional hazard class. In addition, a minor functional hazard class for the loss of transponder function is consistent with the functional hazard class for the loss of ADS-B Out (TSO-C166b) function. Further, reference of the altitude data would clearly identify the type of misleading data that constitutes a major hazard class.	
80	Boeing	Section 3. REQUIREMENTS Paragraph g. Deviations Page 2	The proposed text states: *"We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 14 CFR 21*	We recommend changing the text as follows: *"We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety.*	Text changed, text uses TSO template language.

			Subpart O dated April 14, 2010."	*Apply for a deviation under the provision of 14 CFR 21 Subpart O dated April 14, 2010* ***§21.618****."* We recommend referencing the precise regulation for TSO deviation submittal, per recently released Amendment 21-92 (effective 4/16/2011) as shown below. ***[14 CFR] §21.618 Approval for deviation*** *(a) Each manufacturer who requests approval to deviate from any performance standard of a TSO must show that factors or design features providing an equivalent level of safety compensate for the standards from which a deviation is requested.* *(b) The manufacturer must send requests for approval to deviate, together with all pertinent data, to the appropriate aircraft certification office. If the article is manufactured under the authority of a foreign country or jurisdiction, the manufacturer must send*	

				requests for approval to deviate, together with all pertinent data, through the civil aviation authority of that country or jurisdiction to the FAA.	
81	Boeing	Section 4. MARKING Paragraph a. Page 2	The proposed text states: *"Mark at least one major component permanently and legibly with all the information in 14 CFR 21 Subpart O. The marking must include the serial number…"*	We recommend changing the text as follows: *"Mark at least one major component permanently and legibly with all the information in 14 CFR 21 Subpart O* ***§45.15(b), except as modified within this paragraph****. The marking must include the serial number…"* We recommend referencing the precise regulation for marking, per recently released Amendment 21-92 (effective 4/16/2011). as shown below. Also, please note that the draft TSO requires that a serial number be used whereas §45.15(b)(2) states that a serial number **or** the date of manufacture can be used. ***[14 CFR] §21.616 Responsibility of holder*** *…* *(d) Mark the TSO article*	Text changed, text uses TSO template language.

				for which an approval has been issued. Marking must be in accordance with part 45 of this chapter, including any critical parts; … ***[14 CFR] FAR §45.15 Marking requirements for PMA articles, TSO articles, and Critical parts.*** … (*b) TSO articles. The manufacturer of a TSO article must permanently and legibly mark –* *(1) Each TSO article with the TSO holder's name, trademark, symbol, or other FAA approved identification and part number; and* *(2) Each TSO article, unless otherwise specified in the applicable TSO, with the TSO number and letter of designation, all markings specifically required by the applicable TSO, and* ***the serial number or the date of manufacture*** *of the article or both.* [Highlighting added.]	
82	Boeing	Section 5. APPLICATION	The proposed text states: *"You must give the FAA Aircraft Certification Office*	We recommend changing the text as follows:	Text changed, text uses TSO template language.

		DATA REQUIREMENTS Page 3	*(ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR 21 Subpart O and one copy each of the following technical data to support your design and production approval…"*	*"You must give the FAA Aircraft Certification Office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR 21 Subpart O* ***§21.603(a)(1)*** *and one copy each of the following technical data to support your design and production approval…"* We recommend referencing the precise regulation for application data requirements per recently released Amendment 21-92 (effective 4/16/2011) as shown below. ***[14 CFR] §21.603 Application.*** *(a) An applicant for a TSO authorization must apply to the appropriate aircraft certification office in the form and manner prescribed by the FAA. The applicant must include the following documents in the application:* *(1) A statement of conformance certifying that the applicant has met the requirements of*	

				this subpart and that the article concerned meets the applicable TSO that is effective on the date of application for that article.	
83	Rockwell Collins	Section 3	Change "REQURIEMENTS" to " REQUIREMENTS"		Text changed
84	Garmin	4.a	Marking the functional level, minimum peak output power and optional additional features is impractical and has little or no value. Garmin routinely requests and is granted deviations from such marking requirements to include them in the equipment installation manual as the equipment does not have sufficient space to include all required markings.	Remove the requirement to mark transponder functional level, minimum peak output power and optional additional features. Additionally, strongly urge the FAA to revise its Order 8150.1B CHG 1 TSO marking policy to eliminate the need to routinely request TSO deviations from these marking requirements.	Text based on TSO template, comment forwarded on to TSO template manager. Certain parts can be marked electronically where practical
85	Garmin	4.c	Paragraph 4.c states "If the article includes a deviation per paragraph 3.g of this TSO, the marking should include a means to indicate a deviation was granted." Recently effective rule § 45.15(b)(2) states: (b) TSO articles. The manufacturer of a TSO article must permanently and legibly mark – (2) Each TSO article,	Recommend removing TSO-C112d paragraph 4.c and Order 8150.1B CHG 1 TSO template paragraph 4.c. Recommend adding the following statement in TSO-C112d paragraph 3.g and Order 8150.1B CHG 1 TSO template paragraph 3.g: "Any deviations to this	Text based on TSO template, comment forwarded on to TSO template manager

			unless otherwise specified in the applicable TSO, with the TSO number and letter of designation, all markings specifically required by the applicable TSO, and the serial number or the date of manufacture of the article or both. While this new rule does not appear to contradict the paragraph 4.c requirement to mark the TSO article "to indicate a deviation was granted", the fact remains that most TSO articles have at least one deviation and FAA requires these deviations to be included in the article's installation manual which an installer must use to determine whether the article with deviations can be used in a particular aircraft installation. Furthermore, FAA has routinely granted deviations from other TSOs that have required marking the equipment "to indicate a deviation was granted" since equipment typically does not have sufficient space to include the "deviation granted" marking as well as all other required markings. Consequently, there is no	TSO are required to be included in the Installation Manual."	

			benefit to marking the article "to indicate a deviation was granted" since the currently accepted method is to provide the deviation information in the Installation Manual.		
86	Garmin	5.d	Paragraph 5.d states "If the article includes a simple or complex custom micro-coded component, a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable)." This is inconsistent with AC 20-152 which applies to complex custom micro-coded components only.	Recommend changing Paragraph 5.d to: If the article includes a complex custom micro-coded component, a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).	Text removed
87	Garmin	5.f	TSO-C112d paragraph 5.f and its subparagraphs (which are based on FAA Order 8150.1B CHG 1 TSO template paragraph 5.f and its subparagraphs) include guidance about the definition of non-TSO functions and the data to be submitted to the ACO for non-TSO functions. This guidance is inconsistent with the FAA-industry agreed guidance that was originally published in FAA Notice 8150.6 and	Rather than trying to re-invent the wording associated with defining and managing Non-TSO functionality recommend revising TSO-C112d paragraph 5.f and Order 8150.1B CHG 1 TSO template paragraph 5.f to reference Order 8110.4C CHG 4.	Text based on TSO template, comment forwarded on to TSO template manager

			recently reaffirmed in Order 8110.4C CHG 4. Specific areas of issue with TSO-C112d paragraph 5.f and its subparagraphs (and FAA Order 8150.1B CHG 1 TSO template paragraph 5.f and its subparagraphs) include: Paragraph 5.f states "Identify functionality, features or performance contained in the article not evaluated under paragraph 3 of this TSO (that is non-TSO functions)." Use of the terms "features or performance" in the definition of a non-TSO function is inconsistent with the Order 8110.4C CHG 4 paragraph 6-9.b.(1) and 6-9.b.(3)(a) guidance regarding how to define a non-TSO function and contradicts the following N8150.6 Appendix 2 FAQ, which uses the terms "characteristics", "features", and "performance" and disassociates such aspects from functions that should be declared as non-TSO functions: **7. Q: Are all functions in a TSO article, not**		

			specifically covered by a TSO-approved minimum performance standard (MPS), considered non-TSO functions? **A:** No. Manufacturers often incorporate functions that do not have a direct MPS reference, but that are derived from existing requirements within the MPS. Unlike the non-TSO function, these functions have a direct bearing on the basic TSO operation and are often referred to as "characteristics" or "features" since they are added to enhance performance, usability or integrity of the TSO article. Examples of TSO features might include: the capability to flip-flop the "active" and "standby" frequencies of a communication or navigation radio, facility information (e.g., airport frequencies, runways, airport services available, etc.), built in test (BIT) capability on start-up, and health monitoring to name just a few. Paragraph 5.f indicates that "you must declare these		

			functions and include the following information with your TSO application" but the 5.f subparagraphs which specify the required information to be supplied to the ACO for a non-TSO function are inconsistent with the Order 8110.4C CHG 4 paragraph 6-9.b.(3) "**Manufacturer Data Submittal**" requirements. For example, paragraphs 5.f.(5) and 5.f.(6) require submittal of "Results of test/analysis" while Order 8110.4C CHG 4 paragraph 6-9.b.(3) requires submittal of "proposed test procedures"; while both sets of guidance use the word "test", otherwise there is no similarity.		
88	Garmin	7.a	Items 5.c and 5.d do not need to be provided to each installer. Software and hardware planning documents and accomplishment summaries may contain company proprietary data and do not provide any information of value to the installer.	Recommend that 7.a specify items 5.a, 5.b, 5.e and 5.f.	Text based on TSO template, comment forwarded on to TSO template manager
89	Gary Furr		What is the possibility of mentioning the need to put some sort of "ERRATA" in an Appendix to TSO C112d based on the analysis of the		TSO test procedures significantly rewritten

			problem raised by Kevin Wilson and commented on by yourself with regard to Test Procedure #1 in paragraph 2.5.4.1.2.		
90	Gary Furr		You seem to have several references to different versions of DO-160 in TSO C112d, and none of them are to the current revision "G" version.	I doubt that the lawyers will allow you to change all of those references to "the latest version of DO-160()" but you should either try that, or change all of the references to DO-160G	Use of current version of DO-160 is encouraged but not required. Comment added to TSO-C112f comment log
91	Gary Furr		An error was noted in DO-181E section 2.5.4.1.2, procedure #1. The proposed correction of this section should be incorporated into the LASE TSO		Changes to DO-181E will be incorporated into the LASE TSO after a review of this and other proposed changes are accepted by RTCA SC-209.

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92	AIR-130	A.2.2.6.7	Paragraph specifies AC 20-138C three times. AC 20-138C is about to undergo a revision.	Change “AC 20-138C” to “AC 20-138 (latest revision)”	Text changed
93	Air Services Australia	3 a 2	“Not reply to” should read “Not need to reply to” because the TSO does not forbid replies.	As suggested	Text changed
94	Air Services Australia	A1.2.6	An ADS-B transmission of NIC/SIL=0 is not acceptable because aircraft with INS position sources and no integrity may	Define NIC & NAC & SIL=0 as a declaration of “not useable data”. Allow SIL=1 for LPSE.	SIL=1 is now allowed by the TSO with a static NIC for commercial GPS.

			output NIC/SIL=0 with large position errors. Therefore ADS-B IN systems need to discard NIC/SIL=0 data. Asia Pacific is in the process of publishing a regional procedure requiring non compliant transmitters to transmit NIC or NUC to zero. LPSE needs to transmit non zero NIC or Non Zero SIL to distinguish between INS solution and GNSS solution with RAIM. Maybe SIL=1 would be one way to allow receivers to accept a NIC=0.	If we don't have a belief of 1*E3 then should we use the data? Historically we probably have had 1*E3 from non RAIM receivers. Also change appropriate test requirements	
95	Air Services Australia	A 1.2.6.3 and 4	The GNSS receiver must have detection capabilities for step error, ramp error etc. The TSO doesn't say how the error needs to be flagged. Suggest NIC=0, SIL=0, NAC=0	If a step error is detected, the LPSE shall set NIC,NAC & SIL to zero If a ramp error is detected, the LPSE shall set NIC,NAC & SIL to zero Also change appropriate test requirements	GPS test section rewritten
96	Air Services Australia	A 1.2.6.5	Setting lat/long=0 is not desirable as an error flag because this lat/long is a real position. A more correct method would be to	If interference is detected which could result in misleading data is detected, the LPSE shall set NIC,NAC & SIL to	GNSS section rewritten

			declare the data “bad” eg NIC=0, SIL=0, NAC=0	zero Also change appropriate test requirements	
97	Trig	Draft TSO, Section 3. Requirements.	This section states that an LPSE device may decide to incorporate more capability than what is outlined in this TSO, as long as it meets the MOPS outlined in the referenced documents. However, it is unclear how this applies when there are explicit **shall not** statements made in this document (such as A.1.2.3.2.2 and A.1.2.3.2.3). It may not be clear to readers that a **shall** statement in the full MOPS is more capable than a **shall not** in the TSO.	Modify text to state “…may decide to incorporate more/different capability that what is outlined…”	Text changed
98	Trig	A.1.2.3.2.2	Typographic error. Strikeout should extend backwards by two words to include the words “be accepted”.	Extend strikeout.	Text changed
99	Trig	A.1.2.3.4.3	Typographic error, lefthand box. Word “may” should not be striked out.	Remove strikeout.	Text changed section rewritten
100	Trig	A.1.2.3.4.3	Typographic error, righthand box. Extra comma before word “shall”	Remove comma	Text changed section rewritten
101	Trig	A1.2.5.3	Altitude rate period. Clarification of period, to include time that the rate is greater than 500fpm.	Modify text “… for the next 18 +/- 1 seconds” to be “for the period that the rate is greater than 500fpm and then for a	Text changed section rewritten

				further 18 +/- seconds.	
102	Trig	A1.2.5.3	Question. Do the system need a device that provides altitude rate?		Text changed section rewritten
103	Trig	A1.2.5.4	Error in reference to ED-73D	Modify text to be "ED-73E".	Text changed
104	Trig	A1.2.6.5	Improvement in description request. Reference to setting latitude and longitude to zero – is that mean to be the encoded latitude and longitude? There is a real place where latitude and longitude is zero.	Modify text to detail "encoded latitude and Longitude".	GNSS section rewritten
105	Trig	A1.2.6.5	Question. Is this modification an extension to DO-260B?		GNSS section rewritten
106	Trig	All	We should mention the Corrigendum to DO-260B.	Add reference to Corrigendum.	Text changed
107	Trig	All	Question. Can we confirm that a standard DO-181E/DO-260B transponder with appropriate Altitude encoder and a GPS as described in this TSO forms a valid system as per this TSO?		This TSO provides a standard for a TABS. Systems built to this standard will be valid within the US
108	Eurocontrol	3 a.	"LPSE will not be required to reply to ground sensors although in some cases this may be unavoidable (i.e. Mode C)." is misleading as it could be interpreted as the LPSE will not reply to UF4/5/20/21 however it will replies to	LPSE is not required to be acquired by ground sensors (no reply to ALL call interrogations, no reply to mode A code interrogation) however it will reply to mode C/, UF4/5/20/21 transmitted by ground systems.	Deleted sentence. Topic is covered better in previous paragraph.

			interrogations as defined in the rest of this TSO		
109	Eurocontrol	A1.2.3.1	"SI capability is not required on LPSE, unless Mode S All-Call capability is provided." is unclear. Is DI=3 supported in UF4/5/20/21?	Lockout protocols are not required on LPSE, unless Mode S All Call capability is provided.	Text changed
110	Eurocontrol	A1.2.3.2.4.2.	Modified text for this TSO " Ground-to-Air Mode S Acceptance – Mode S interrogations, excluding UF0 and UF16 may be accepted at the Mode S MTL (§2.2.2.4 b) +3dB ± 1dB. " Meaning not understood. Is it to not reply to UF4/5/20/21 between MTL and MTL + 3 dB?	Please clarify what you want to say.	Text slightly modified. The comment interpretation is correct.
111	Eurocontrol	A1.2.3.3.3.	Roll Call (selective) interrogation will be received from WAM systems able to acquire the aircraft through multilateration on any replies transmitted by LPSE	Selective interrogations addressed by ground systems would be small. Only addressed interrogations from ground systems using passive acquisition (eg multilateration) are expected to happen.	Agree that WAM acquisition would be non-zero, but probably within the allocated budget for existing requirements.
112	Eurocontrol	A1.2.5.2.	Why transmission rate be half of normal rate? The same rate should be kept in order to ensure effective decoding (see ACAS Xu coordination rate study presented at the last ICAO	Should keep the same rate than normal ADS-B	Text changed

			ASP WG meeting WP AS14-04 section 4.4) and therefore requiring an increase of RA report transmission rate.		
113	Eurocontrol	A1.2.5.4.	LPSE is based on a Mode S transponder level 2 as specified before	Remove “If the ADS-B transmitter is based on Mode S transponders, then “	Text Changed
114	Eurocontrol	A1.2.5.4	Latest version of EUROCAE ED-73 is E.	Please replace D by E after ED-73	Text changed
115	Eurocontrol	A.3.5.3.1.	Table 22 source of reply rates (2007-2020) not clear. Should more clearly points to the study Current measurement in Europe show higher reply rates (1s peak)	Clarify content of the table	Text changed. Data pulled from Table 2 and 3 in the HPA study. A link to the study is noted in the reference section of the TSO on page 8. You can download a copy of it here: http://www.hpa.org.uk/Publications/Radiation/HPARPDSeriesReports/HpaRpd031/
116	Eurocontrol	General	A LPSE unit will have different capabilities. It might be good to have the possibility to know that a unit is an LPSE through the messages it transmits. This should be available through BDS 10 for ground system, should ground systems be able to detect them, and through an ADS-B message. The indication will be useful when investigating why an aircraft will be detected by a WAM or an ADS-B system and not	Add a bit in BDS 10 to indicate LPSE capability (e.g. bit14) Add a bit in an ADS-B reserved field (for example in Aircraft operational status message) to indicate LPSE capability	Text changed. LASE class of devices added to Typecode 31 Aircraft Operational Message format

			detected by a radar. Please consider inserting information in messages to indicate that the unit has the capability of a LPSE		
117	NavWorx	1. Purpose	LPSE which could be implemented as a UAT would also be visible to all listed equipped aircraft via ADS-R technology	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by TCAS equipment and would not address a key factor that led to the accident.
118	NavWorx	1. Purpose	UAT, by design, has lower power requirements than transponder based technologies.	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by TCAS equipment and would not address a key factor that led to the accident.
119	NavWorx	1. Purpose	LPSE devices implemented as UAT would provide the equivalent safety levels as specified in this document.	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by TCAS equipment and would not address a key

					factor that led to the accident.
120	NavWorx	1. Purpose	Aircraft equipped with collision avoidance systems and traffic advisory systems can see and will be seen by UAT equipped aircraft	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by TCAS equipment and would not address a key factor that led to the accident.
121	NavWorx	1. Purpose	LPSE implemented with UAT would not need to have reduced capability.	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by TCAS equipment and would not address a key factor that led to the accident.
122	NavWorx	3.a.5	LPSE implemented with UAT could implement the reduced position source requirements of this section	Specify TSO-C154c devices with SIL=0 as part of TSO-C199 (NavWorx has this solution available for sale today).	FAA research into commercial GPS chipsets was conducted with the help of General Aviation manufacturers and the WAAS team at the FAA Technical Center. The final requirements for the GPS receiver performance allows SIL=1.
123	NavWorx	Entire document	This TSO proposal is a waste of tax payer resources. It is biased against UAT technology on the implied basis that it wouldn't meet the safety requirements of allowing previously equipped aircraft with TCAS/TAS	Allow UAT Out devices as part of TSO-C199	TSO-C199 is intended to address several issues for aircraft currently exempt from ADS-B and Transponder rules. One of these issues is an NTSB recommendation stemming from the mid-air collision of a glider and biz-jet near Reno, NV. This NTSB recommendation advised the FAA to remove the transponder exemption from gliders specifically so they could be tracked by TCAS equipment. UAT equipment cannot be tracked by

			equipment to be visible. The FAA is spending billions of dollars in implementing a mandated system that <has> been determined to provide more safety than the current proposed system, yet the implementation of this document somehow comes to a different conclusion. Aircraft that will not have to meet the 2020 mandate for ADS-B could implement UAT technology with position source that meets TSO-C199 requirements: these devices are available today, at low cost and low power.		TCAS equipment and would not address a key factor that led to the accident.
124	Accord Technology	A1.2.6.1	NACp >=1 requirement seems to be too loose, since that indicates the HFOM to be less than 10 NM	NACp >= 3 perhaps will be more appropriate	See A.1.2.6.3, 30 meters required when HDOP < 2.5.
125	Accord Technology	A1.2.6.1	NACv >= 1 requirement seems to be too loose	NACv >= 2 perhaps will be more appropriate	NACv=1 is the rule requirement in ADS-B Out airspace 14 CFR 91.227.
126	Accord Technology	A1.2.6.2	SIL = 3 if NIC > 0 SIL = 0 if NIC 0 Since as per 3.a.5, 3.b and 3.e the software has to be DO-178B Level D, i.e. 'minor failure condition', shouldn't the SIL be = 1?	Make the NIC, SIL and failure conditions consistent with each other	SIL=1 see A.1.2.5.6
127	Accord Technolog	A1.2.7.1	It is not clear whether the GNSS antenna should be	Clarify that the GNSS antenna need not be	Text changed

	y		TSO'd. Since the LPSE device is battery powered, standard TSO-C190 or TSO-C144 antennas will not be suitable.	TSO'd	
128	Accord Technology	A2.2.6.2	This refers to DO-229D, Change 1, Section 2.5.9.3 as a method to compute NIC. If the receiver can not compute integrity shall output NIC = 0 The question is if NIC = 0, will that be acceptable?	Clarify if NIC = 0, is it acceptable.	Text modified see A1.2.5.6
129	Accord Technology	A2.2.6.3 A2.2.6.4 A2.2.6.5 A2.2.6.6 A2.2.6.7	These Sections refer to DO-229D, Change 1 Section 2.5.3, 2.5.9.3, 2.5.7, 2.5.8 and AC-138C Appendix 4 for Step error detection, Ramp error detection, Interference rejection and accuracy and NACv tests respectively Performing the above tests are quite difficult and in most cases a commercial receiver may not be able to satisfy these requirements	Provisions for alternate methods to test these could be allowed. Accord Technology will propose alternate test procedures	GNSS section rewritten
130	Doug Arbuckle	A1.2.3.2.4.2	It is unclear if this section is consistent with A2.2.3.2.5. In the commented section, it says "Mode S interrogations, excluding UF0 and UF16, may be accepted…" but A2.2.3.2.5 seems to be a test for UF0, UF16 and	Resolve inconsistency, if it exists.	Language clarified see A1.2.3.10.2

			other UF formats.		
131	Doug Arbuckle	A1.2.3.5.1	I do not understand why IDENT is even optional, nor why a 4096 code needs to be set. To my knowledge, there is no air-to-air use for IDENT. I am unclear on the need for a specific 4096 code (why isn't "0000" preset and then OK) for air-to-air use. You should also consider why 4096 code is a "required indicator".	Delete any requirement for IDENT and revisit the need for a 4096 code for air-to-air use only.	Ident allowed per discussion with International ANSPs.
132	Doug Arbuckle	A1.2.3.5.6	Why is there a need to initiate IDENT for air-to-air use?	Delete any requirement or suggestion for IDENT functionality unless a compelling need can be identified for air-to-air use.	Ident allowed per discussion with International ANSPs.
133	Doug Arbuckle	A1.2.5.7.1	I'm not sure that some of these ADS-B "optional" capabilities should be allowed – for example, IDENT, 4096 code, Emergency/Priority status, etc.	If some of these "optional" capabilities are allowed (e.g., Emergency/Priority status), some of them (see e.g.) should only be permitted if a pilot control is provided.	Text changed
134	Garmin	3.	This paragraph contains the first mention of equipment class. Yet, no equipment classes are defined in the TSO. It can be inferred that the 'functions' identified in 3.a.(1) are intended to be the 'classes'. There is a lot of ambiguity here. The TSO seems to be	First, remove the references to 'class' in the last sentence of the last paragraph: New models of the LPSE identified and manufactured on or after the effective date of this TSO must meet the MPS	Equipment classes rewritten

			written such that the functions can be implemented in distinct appliances. This should be stated more clearly.	qualification and documentation requirements for the applicable ~~equipment class~~ function(s) defined by this TSO. Second, include a statement that functions may be implemented in separate appliances.	
135	Garmin	4.a	The marking section includes the statement "The marking must include the serial number and functional equipment class in accordance with paragraph 3." Again, classes are not defined in this TSO. Rather, functions are defined. The TSO should define a method of marking to indicate which function(s) are implemented in the equipment.	Define a marking method to identify which functions are supported by the equipment. Single letters (akin to TSO-C112d) should suffice.	Text changed to improve readability and Class defintions.
136	Garmin	7.c	The item is blank. In the first draft of this TSO, this stated, "The LPSE manual and installation manual shall clearly state "Does not meet requirements for use in Mode S rule airspace defined in 14 CFR 91.215 and ADS-B rule airspace as defined in 14 CFR	Update the item as appropriate.	Yes. Description of LASE capability found in para 1 Purpose and 3 Requirements

			91.225."” Was it deleted on purpose?		
137	Garmin	Appendix 1, § A1.2.3	The transponder function requirements do not indicate that the extended squitter transmission rates should be reduced	Add a section addressing the changes to DO-181E section 2.2.23.1.3 that will address the transmission rate modifications of section A1.2.5.2. Ideally, it would just be a reference to the DO-160B transmission rates as modified by A1.2.5.2.	Text changed
138	Garmin	Appendix 1, § A1.2.3.4.3	The ‘Modified Text for this TSO’ does not seem to differ in meaning from the original DO-181E text. In fact, the reference to a DO-181E section (2.2.3.4.2) that was modified in A1.2.3.3.4.3 actually confuses things further.	Remove this section. The DO-181E text is clear.	Text changed DO-181 section rewritten
139	Garmin	Appendix 1, § A1.2.3.5.1	Required indicators for in flight are ‘Transponder Fail’ and ‘ADS-B Fail’. What is the purpose of annunciating separate failures? It is assumed that the intent is to inform the operator of GPS position data failures as well as device failures. DO-260B allows these failures to be combined, why doesn’t this TSO?	Combine the ‘Transponder Fail’ and ‘ADS-B Failure’ indicators into a single ‘Device failure’ indication. Note that combined indicator must indicate a transponder *or* ADS-B function or device failure. Also note that separate failure indications can be implemented.	The intent of the separate indications is to allow the operator to distinguish between these two failures. DO-260B allows them to be the same, but the Advisory Circular requires there to be a means to distinguish which failure has occurred by another means in the installation. This language was aimed at retro-fit air transport category aircraft. LASE installations are intended for general aviation aircraft with little to no electronics. It is unlikely that there would be a viable alternate means simpler than say including a LED on the unit for example.
140	Garmin	Appendix 1,	The draft TSO states that an aviation grade GNSS	If the intent is to allow the use of non-TSO	GNSS requirements and test procedures rewritten

		§ A1.2.6.1	position source that meets a published TSO is not required for LPSE. However, the TSO also requires that the GNSS position source must be screened using the test procedures in Appendix 2. Most of the test procedures for GNSS position sources defined in Appendix 2 § A2.2.6 are simply references to GNSS TSO test procedures. In many cases, these test procedures are based on the assumption of a receiver designed to meet the current GNSS TSOs (i.e. uses a weighted least squares position solution and an FDE algorithm consistent with RTCA DO-229D). These test procedures are inconsistent with the statement that LPSE is not required to use a TSO-compliant GNSS position source.	commercial GPS chipsets in LPSE, then the test procedures should be redesigned so that they are not dependent on a receiver design that is compliant with a TSO. See additional Garmin comments on specific test procedures.	
141	Garmin	Appendix 1, § A1.2.6.1	The draft TSO states: "The position source must reject the injected errors and either drop the affected pseudorange measurement	Reword this text similar to the following: "The position source must reject the injected errors and either drop the	GNSS requirements and test procedures rewritten

			from the solution, Fault Detection and Exclusion (FDE), or fail the solution." The reference to FDE seems like it should be parenthetical rather than part of the sentence.	affected pseudorange measurement from the solution (i.e. fault exclusion) or fail the solution (i.e. fault detection)."	
142	Garmin	Appendix 1, § A1.2.6.2	Unless there is an operational benefit for TSO-C199 equipment to broadcast NIC > 0, it is unlikely that manufacturers will take on the expense of developing and certifying RAIM/FDE in this equipment. As a result, the FAA should expect that most LPSE will broadcast NIC = 0. While commercial GPS chipsets likely provide some form of FDE, this will be tailored for terrestrial multipath as opposed to satellite failure modes. Even if FDE is implemented in the commercial GPS chipset it is highly unlikely that the chipset provides a horizontal protection level or uses the same probability of missed detection as a certified		GNSS requirements and test procedures rewritten

			GNSS receiver.		
143	Garmin	Appendix 1, § A1.2.6.4	RAIM or some sort of GPS integrity channel is generally required to detect ramp errors. Since neither capability is required of LPSE per Appendix 1, § A1.2.6.2, this requirement should not apply to LPSE equipment that broadcasts NIC = 0 and SIL = 0.	Exempt LSPE equipment outputting NIC = 0 and SIL = 0 from the ramp detection requirement.	GNSS requirements and test procedures rewritten
144	Garmin	Appendix 1, § A1.2.6.5	While it is possible to detect some types of interference without using RAIM/FDE, it is not clear that detecting errors caused by interference can be accomplished without RAIM/FDE, which is not a minimum requirement. It should be sufficient for the LPSE to withstand interference without generating misleading information. Detection is not required.	Reword this requirement as follows: "LPSE should not transmit false or misleading information in the presence of interference. Loss of positioning capability is acceptable. Testing to determine the interference capability of a GPS system is outlined in Appendix 2, section A2.2.6.5 of this TSO."	GNSS requirements and test procedures rewritten
145	Garmin	Appendix 1, § A1.2.6.5	This section states that the LSPE **should** detect errors caused by interference, but the associated test section (Appendix 2, § A2.2.6.5) states that the interference rejection test **shall** be run. It is not clear if the	Make sections A1.2.6.5 and A2.2.6.5 consistent.	GNSS requirements and test procedures rewritten A1.2.6.5 and A2.2.6.5 both say SHALL

			detection of errors caused by interference is mandatory or optional.		
146	Garmin	Appendix 2, § A2.2.6.2	The DO-229D offline simulations referenced (DO-229D § 2.5.9.3) require that the simulation software use navigation, integrity, and satellite selection algorithms that are functionally identical to those used in the GNSS receiver. For commercial GPS chipsets, these algorithms may not be readily accessible to LPSE manufacturer. This would be another incentive for LPSE to output NIC = 0 and SIL = 0.	Develop alternate test methods to verify the NIC value of the LPSE that does not require intimate knowledge of the GNSS receiver design.	GNSS requirements and test procedures rewritten
147	Garmin	Appendix 2, § A2.2.6.2	The DO-229D offline simulations referenced (DO-229D § 2.5.9.3) include geometries to test both the fault detection (Set 1) and exclusion (Set 2) functions. Per Appendix 1. § A1.2.6.1 the GNSS equipment is not required perform exclusion (i.e. they do not need to work through single satellite failures).	State that GNSS equipment not capable of performing fault exclusion only needs to conduct tests using the Set 1 geometries.	GNSS requirements and test procedures rewritten

			The Set 2 geometries should not be required for GNSS equipment that does not perform the exclusion function.		
148	Garmin	Appendix 2, § A2.2.6.3	While it is likely that consumer GPS chipsets can detect and exclude pseudorange steps, it is unlikely that they have been developed to be compliant with DO-229D standards. DO-229D § 2.5.3 includes multiple step detector tests, however, only the tests defined in section 2.5.3.1 apply to all classes of equipment. The tests in 2.5.3.2, 2.5.3.3, and 2.5.3.4 only apply to GPS equipment capable of supporting vertically guided approaches and do not seem appropriate for LPSE equipment. The DO-229D step detector tests also specify that the step is put on the "hardest-to-detect" satellite, which is not particularly meaningful for a commercial GPS chipset that does not implement RAIM/FDE. Additionally, some of the	Consider eliminating the step detector requirement for LSPE that only outputs NIC = 0 and SIL = 0. If the step detector test is needed, limit the required tests to those specified in DO-229D § 2.5.3.1. Modify the pass criteria for these tests so that only size of the positioning error is checked. In order to avoid confusion regarding the "hardest-to-detect" satellite, the test procedure could specify a particular satellite geometry along with the particular satellite that would be considered hardest-to-detect in that geometry.	GNSS requirements and test procedures rewritten

			pass criteria specified in DO-229D § 2.5.3.1 may not verifiable with consumer GPS chipsets – specifically the indication of the removal of a particular satellite from the solution and the indication of a loss of integrity monitoring. Finally, it's not clear why this test is necessary for LSPE that sets NIC = 0 and SIL = 0, as this indicates that the position source has an unknown position integrity level.		
149	Garmin	Appendix 2, § A2.2.6.4	The DO-229 section 2.5.9.3 offline simulation tests are intended to verify the performance of the fault detection and exclusion algorithms in the GPS receiver. RAIM/FDE algorithms are not required per Appendix 1, § A1.2.6.2 of this TSO provided the LSPE set NIC = 0 and SIL = 0. Therefore this test does not seem appropriate for this equipment.	Exempt LSPE equipment outputting NIC = 0 and SIL = 0 from performing the DO-229D section 2.5.9.3 tests.	GNSS requirements and test procedures rewritten
150	Garmin	Appendix 2, § A2.2.6.4	The DO-229D offline simulations referenced (DO-229D § 2.5.9.3) require that the simulation	Exempt LSPE equipment outputting NIC = 0 and SIL = 0 from performing the DO-229D section	GNSS requirements and test procedures rewritten

			software use navigation, integrity, and satellite selection algorithms that are functionally identical to those used in the GNSS receiver. For commercial GPS chipsets, these algorithms may not be readily accessible to LPSE manufacturer.	2.5.9.3 tests.	
151	Garmin	Appendix 2, § A2.2.6.5	The DO-229D § 2.5.7 interference rejection test is not an appropriate test to apply to GNSS receivers that have not been designed to meet FAA TSOs. It is based on the assumption that the equipment uses a weighted least squares positioning algorithm and the integrity algorithms specified in DO-229D. The pass/fail criteria for this test are defined in the ranging accuracy domain and rely on outputs (sigma_noise) that would only be generated by a TSO GNSS receiver. While the DO-229D § 2.5.7 test is called an interference rejection test,	Specify an alternate test that verifies that the GNSS position source does not output misleading information (i.e. erroneous position) in the presence of interference. The pass/fail criteria should be defined in the position accuracy domain and loss of positioning capability should be an acceptable result. A potential set of test cases could include testing each of the interference conditions specified in DO-229D appendix C and increasing the interference level until the receiver lost the ability to compute a position fix.	GNSS requirements and test procedures rewritten

			it is really a test of the receiver's ability to exclude measurement errors induced by interference. Per Appendix 1, § A1.2.6.1, exclusion capability is not a minimum requirement for GNSS position sources used in LPSE.	The positioning accuracy could be compared against the NACP value to ensure that the 95% overbounding requirement is met while the receiver is reporting a valid position. This type of testing could be performed with either conducted or radiated signals and would be better suited to LPSE that has the GPS antenna and receiver integrated into a single assembly.	
152	Garmin	Appendix 2, § A2.2.6.6	The DO-229D § 2.5.8 accuracy tests are not appropriate tests to apply to GNSS receivers that have not been designed to meet FAA TSOs. They are based on the assumption that the GNSS position source uses a weighted least squares positioning algorithm. The tests require outputs that would only be generated by a TSO GNSS receiver. The GPS and noise levels specified in these test procedures are defined relative to a MOPS	Specify an alternate test that is not based on outputs only available on TSO GNSS receiver. The test(s) should evaluate GNSS receiver position accuracy and verify that the NACP is a 95% bound on the horizontal position error. A combination of simulator and live signal tests could be conducted. The tests should include a dynamic component, as many commercial GPS chipsets include Kalman filter position algorithms that behave differently in	GNSS requirements and test procedures rewritten

			compliant GPS antenna that would not likely be used with LPSE. Finally, the 2.5.8 tests only verify GPS receiver accuracy and do not verify that the NACP output is a 95% bound on the horizontal position error.	static and dynamic scenarios. GPS and noise power levels should be specified in a way that allows the test to be performed with either conducted or radiated signals to accommodate LPSE that integrate the GPS receiver and antenna into a single assembly.	
153	Tom Pagano	A1.2.5	I only had one significant comment which deals with the ADS-B Out requirements in A1.2.5. I recommend not allowing the transmission rate of extended squitters to be halved as defined in A1.2.5.1. This TSO is better served if it reduces the transponder function and not the ADS-B function. Keeping this equipment as standard A0 equipage keeps this equipment in conformance with ADS-B standards, an advantage to the overall airspace as ADS-B applications develop in the future and more readily keeps the door open if it is decided that ground systems would like to track this community of aircraft.		Text changed

			If the comment above is rejected, I would counter propose that the Operational Status Message rate not be halved; only halve the Airborne Position and Velocity Message. The Operational Status Message is nominally every 2.5 seconds and .8 seconds upon change of key parameters. I think it would be best to insure that this rate is maintained. Also, please note that the SDA requirement of 1 precludes TCAS HS to use their ADS-B in extended hybrid surveillance. There is no allowance for setting it to better than 1.		
154	Tom Pagano		Also, please note that the SDA requirement of 1 precludes TCAS HS to use their ADS-B in extended hybrid surveillance. There is no allowance for setting it to better than 1.		Agree. LASE will be tracked as a Mode S target by a hybrid surveillance TCAS. Text modified.
155	Universal Avionics		No comment		Noted
156	NATS UK		During the Second public meeting, Mr. Hayward noted that gliders in the UK would need to be able to change their 4096 code in flight		Text changed

Consolidated Public Comments for TSO-C199					
#	**Name**	**Paragraph Section**	**Comment**	**Suggested resolution**	**AIR-130 Disposition**
157	AIR-130		The description of how this TSO can be used with or without a TSO'd transponder or with to without a TSO'd GPS system shoul be written more clearly.	Rewrite description of this in the TSO	Para 3 a (5) added describing how a LASE device should be marked Advisory Circular material will also address this.
158	AIR-130		Bits should be added to distinguish an LASE device from a device TSO'd to 112, 145, 146, 196 or 196	Add bits in Airborne Capability Class Type Code 31.	Text changed. Requirement added Testing para added

159	Air Services Australia	3a	There is confusion about the Classes of LASE. The words imply that a LASE can be a) A single box comprising Transponder function, altitude source and ADS-B outs functions. **Class A LASE**. A second box needs to be provided at installation time to deliver position data to this box b) A single box comprising Transponder function, altitude source and ADS-B outs functions and GPS function. **Class B LASE.** Later paras say this does not require software qualification, environmental qualification or hardware qualification. Would the transponder function require some qualification? **Another interpretation could be that a LASE can be a single box comprising**	Clarify and define classes.	Para 3 a, reworded to better clarify LASE classes

160	Air Services Australia	4d.	Electronic marking – Could the special tools used to display this be the same as that to program 4 digit octal code, Flight ID etc? Would the tool that is used to program 4 digit octal be considered "a special tool or equipment"	Clarify	Text consistent with Order 8150.1C Technical Oder Standard Programs
161	Air Services Australia	A1.2.1	"If electing to implement full functionality…..". I think you are trying to say that each function, when implemented must meet TSO-C181E or DO260B as appropriate. The word "full" is unclear. The designer may choose to offer less than "full" but more than that required by this TSO.	Allow over compliant solutions that are not full compliance with the TSO/DO : "Each function, when implemented must meet the requirements of TSO-C181E or DO260B as appropriate."	Para rewritten to clarify
162	Air Services Australia	A1.2.3.2.1	There are no "changes" to DO181E. It remains unchanged.	The requirements of this TSO, are identical to DO181E except for the changes shown below:	Text changed

163	Air Services Australia	A1.2.3.2.2	"shall not be accepted" A designer could presumably choose to accept All Call interrogations under this TSO. I think you are saying that it is not necessary for the box to accept the All Call. I would like to think that some low cost transponder boxes could obtain LASE TSO certification, using existing transponders with lower performance GPS. If the REQUIREMENT is that the LASE not accept interrogations then these boxes could not qualify. They should be allowed to be "over-compliant". The same comment applies to A1.2.3.2.3 and A1.2.3.2.4.1 and A1.2.3.2.4.2 I note that this may then cause some problems with the definition of reply rate capabilities later on.	..the received interrogation may be rejected (NB: To maximize power saving it is desirable to not accept this interrogation)	This modified requirement is a SHALL if followed. If it is not followed, minimum requirements outlined in the applicable section in DO-181E applies.
164	Air Services Australia	A1.2.3.5.1	Under maintenance actions – add "optional : display software version "		Text added

165	Air Services Australia	A1.2.5.2 Table 18	Remove "If the ADS-B transmitter is based on Mode S transponders" because para A1.2.5.1 says that the ADS-B function must be 1090. ie: There is no "IF".		Text removed / modified
166	Air Services Australia	A1.2.5.4	The list of position sources – should this include TSO C-196 ? TSO C196 should allow NIC/NAC and SIL to be set in accord with DO260B.		Text changed. TSO-C196 and TSO-C206 added.
167	Air Services Australia	A1.2.5.4	<If Class A means external GPS> then why would you REQUIRE NIC=6 SIL=1. The designer could choose to install at TSO145 engine inside a class B box. In this case it would be preferable to allow a real NIC to be generated. The designer could choose to install at TSO145 engine outside the transmitter box. In this case it would be preferable to allow a real NIC to be generated.	When LASE is installed with a position source which is not compliant with TSO C.then the transmitted NIC shall be set…. Maybe there is value in defining at the start two classes of position source. Class X= TSO C145, TSO146…..Class Y= A reduced capability GPS meeting the requirements of para A1.2.6. Then say If a class Y GPS source is used, then set NIC=6 & SIL=1	Text changed. LASE classes clarified in para 3 a.
168	Air Services Australia	A1.2.6	Isn't this only applicable for Class B ?	Change title to Class B GNSS Position Source Function Requirements	Text changed

169	Air Services Australia	A1.2.6.10 A1.2.6.5, A1.2.6.3	"more accurate than". Do you mean only transmit when the declared accuracy is better ? Is this 95 percentile? How is it determined or achieved? - the GPS receiver accuracy output depends on the satellite constellation.	Clarify what this means.	Text changed.
170	Air Services Australia	A1.2.6.1	"Significant ramp error once a year " is in excess of what we (think) we see. Are you able to provide details on some of these events? (even just the last event).		Please refer to the WAAS Test Team website where you can find quarterly reports on GPS and WAAS performance. http://www.nstb.tc.faa.gov/
171	Air Services Australia	A2.2.2.3.2.	Is it mandatory that a LASE reject all call interrogations? These tests should only be required for boxes that indeed declare that they do not reply.		Text changed. Para A1.2.1 reworded to clarify
172	Air Services Australia	A2.2.2.3.2	"should verify that changes made to RTCA/DO-181E" There have been no changes to DO181E. It is a stand alone document.	Should verify that the requirements of this TSO expressed in para xxx,yyy are satisfied.	Text changed
173	Air Services Australia	A2.2.6.1	Should this include TSO196. If not – why not for Class A ? In a non SBAS environment this would be just as good.		Text changed, Reference to TSO-C196 and C-206 added

174	Air Services Australia	A2.2.6.4.1.1	Could not the test be successful if the GPS declared the output faulty (rather than removing the satellite from the solution).	In order to pass the test, either : a) the satellite with the step error should be …. OR b) the position output is declared invalid	Test is to ensure step errors are detected and removed from the solution.
175	Air Services Australia	A1.2.6.8	Would be useful to advise what this bit is.	This bit signals advice from the satellite that the signal should not be used for "safety of life" applications.	All terms are defined in DO-229D
176	Air Services Australia	A1.2.4.1	Is a TSO C88b certification required – or is this simply saying that "it must meet the performance requirements of TSO-C88b	Change to "performance requirements"	Text changed
177	Air Services Australia	A1.2.6.10	I agree that it is desirable to transmit GNSS HAE – but is it essential – for what purpose – where is it used (it is not used by ATC that use baro).	Add (desirable)	HAE is required for air-to-air applications
178	Air Services Australia	A2.2.5.7.1	An "over-compliant" solution using an existing transponder may reply to Mode S all call.	Add If the optional "Reply to mode S all call" is included, test as per DO-181E	Additional capability of a unit that is described in DO-181E must meet the MOPS therein, ref para A1.2.1
179	Air Services Australia	A2.2.5.7.1	An "over-compliant" solution using an existing transponder may reply to ATCRBS	Add If the optional "Reply to ATCRBS" is included, test as per DO-181E	Additional capability of a unit that is described in DO-181E must meet the MOPS therein, ref para A1.2.
180	Air Services Australia	A1.2.3.2.4.2	Is the "modified text" a requirement or not. It uses the word "may".		Text changed

181	Air Services Australia	A2.2.6.3.2.4.1.1	This simulation uses the standard 24 sat constellation WITHOUT SBAS	This test is conducted without simulation of a SBAS signal.	This test is verifying the performance of the GNSS system, not the capability to use SBAS information
182	Air Services Australia	A2.2.6.6	Change name : Verification of Performance in an SBAS environment		Para A2.2.6.6 focuses on interference tests and is unrelated to SBAS.
183	Air Services Australia	A2.2.6.8	This works in an SBAS environment. But do commercial receivers discard satellites that self declare that they are in maintenance or unhealthy? Would it make sense for this requirement to be included in the A2.2.6 non-SBAS tests		There is no requirement for a non-SBAS GPS commercial receiver to do this.
184	Air Services Australia	A2.2.6.9.2.2	The following sentence is unclear about what is being compared. *In order to pass the test, the horizontal and vertical position accuracy output must be greater the actual position error at least 95% of the time.*	*Compare the HFOM against the horizontal position error for each valid position estimate.* *Compare the VFOM against the vertical position error for each valid position estimate.* *In order to pass the test, the HFOM & VFOM output must be greater than the actual position error at least 95% of the time.*	Text changed

185	CASCADE	General	Missing Indication of LASE equipment in BDS 65 (using the two bits recently assigned by the ICAO ASP)	Add indication of LASE. Suggested definition (TBD): 00 – No (LASE) information 01 – LASE class AB 10 – Reserved 11 – Reserved	Text changed Para A1.2.5.9.1 and A2.2.5.9.1 added
186	CASCADE	Section 1, first bullet	Text states ”Specifically, LASE devices: Are intended to be used on aircraft that are exempted from carrying a transponder or Automatic Dependent Surveillance - Broadcast (ADS-B) equipment, such as gliders, balloons and aircraft without electrical systems.” Are aircraft actually “exempt” (in Europe this term is used for aircraft that would fall under a Rule but are then exempted for reasons such as disproportional costs), or are they simply operating in airspace where ADS-B Out is not required?	Replace with: ”Specifically, LASE devices: Are intended to be used on Light Aircraft, such as gliders, balloons and aircraft without electrical systems”. Possibly add “when not subject to more stringent transponder or Automatic Dependent Surveillance - Broadcast (ADS-B) equipment requirements.”	91.215 b (5) in the Mode S rule, allows for exceptions from the rule “All aircraft except any aircraft which was not originally certificated with an engine-driven electrical system or which has not subsequently been certified with such a system installed, balloon, or glider.” 91.225 para e in the ADS-B rule states “(e) The requirements of paragraph (b) of this section do not apply to any aircraft that was not originally certificated with an electrical system, or that has not subsequently been certified with such a system installed, including balloons and gliders.”

187	CASCADE	Section 1	Suggest to clarify that LASE may include more functionality. Text stating: "LASE will enable an aircraft to be visible to other aircraft equipped with:" <5 bullets>	"At minimum LASE will enable an aircraft to be visible to other aircraft equipped with:" <5 bullets> "If installed with full transponder functionality, LASE will in addition enable an aircraft to be fully interoperable with ground surveillance systems relying on the transponder, such as WAM, and SSR systems."	Text changed. Intent of this paragraph is the state the minimum capabilities of LASE equipment, not discuss advantages of additional optional capabilities
188	CASCADE	Section 3	Suggest to make the following sentence more generic: "Equipment meeting these requirements will provide the capability to be seen by other aircraft equipped with traffic advisory systems but may not support Secondary Surveillance Radar surveillance (SSR) systems."	Proposed text: "Equipment only meeting the minimum LASE requirements will provide the capability to be seen by other aircraft equipped with traffic advisory systems but may not support (sufficient) detection by surveillance systems relying on full transponder functionality such as Secondary Surveillance Radar (SSR) and Multilateration (MLAT or WAM) systems."	Text changed

189	CASCADE	Section 3	The introductory paragraph states that LASE equipment "may not support Secondary Surveillance Radar surveillance (SSR) systems". We presume that this relates to the +3dB larger Mode MTL for UF4, 5, 20, 21. If that is the case, the sentence should say "may not fully support". If not, it should be explained what is meant.	See comment.	Text changed
190	CASCADE	Section 3 & 4	Suggested to clarify upfront that it is acceptable to install a 145(204)/146(205) receiver with a LASE system. – Moreover, TSO-129(A) and TSO-196 should be able to support LASE as well. It is not understood why these are excluded. They do not support SBAS but have RAIM. For this TSO version, SBAS was decided as a minimum for COTS GPS to achieve RAIM like behavior. It is therefore not understood why RAIM only is not accepted.	Consider the addition of TSO-2129(A) and TSO-196.	Text changed

191	CASCADE	Section 8	Item b: add hyperlink to Eurocontrol Surveillance library.	Please add https://www.eurocontrol.int/articles/surveillance-library	Reference added
192	CASCADE	Section 8 / A4.2	Repetition of references.	Consider using one location only.	Reference left in both locations This is driven by the standardized TSO template
193	CASCADE	A1	The introduction should focus also on the benefits for the user of LASE, such as that LASE is an alternative/improved/low cost means for enabling Traffic Collision risk detection and situation awareness between equipped aircraft. In addition, LASE is possibly enabling some ATC surveillance services, for example SAR and FIS.	Consider mention of additional benefits.	Text added
194	CASCADE	A1.1	Text states ”LASE devices are intended to be used on aircraft that are **exempted** from carrying a transponder or Automatic Dependent Surveillance - Broadcast (ADS-B) equipment, such as gliders, balloons and aircraft without electrical systems.”	See related CASCADE comment on Section 1, first bullet. (It is noted that this applies to any mention of “exempt” throughout the document.)	91.215 b (5) in the Mode S rule, allows for exceptions from the rule “All aircraft except any aircraft which was not originally certificated with an engine-driven electrical system or which has not subsequently been certified with such a system installed, balloon, or glider.” 91.225 para e in the ADS-B rule states “(e) The requirements of paragraph (b) of this section do not apply to any aircraft that was not originally certificated with an electrical system, or that has not subsequently been certified with such a system installed, including balloons and gliders.”

195	CASCADE	A1.1, bullet 5	Suggest to also spell out the ADS-B In applications: AIRB, TSAA, SURF - to balance the details related to TCAS systems and emphasis the ADS-B based benefits, especially from TSAA between LASE aircraft.	Aircraft with ADS-B In capability as defined in TSO-C154c, TSO-C166b, and TSO-C195a. The ADS-B In capability includes Basic Airborne and Surface Situation Awareness (AIRB, and SURF at least while airborne) as well as ADS-B based traffic collision detection provided by the Traffic Situation Awareness with Alerts (TSAA) application.	ADS-B Applications are spelled out in TSO-C195a. TCAS / TAS references are provided because they have separate TSO's.
196	CASCADE	Table 11	Is missing.	Correct Table numbering.	Text changed
197	CASCADE	A1.2.3.5.1. Table 12 also Table 14	Display (and possibly setting) of Flight ID (and possibly 4096 codes) needs to be possible in flight. Flight ID is needed for both air-air and air-ground interaction, a transmitter need to know what his own system is transmitting as identification. 4096 codes maybe needed in air-ground interaction cases, as possibly applicable to LASE class B position sources integrated with a "full transponder" system (incl. indication of emergency conditions).	1. Add Flight ID for display in flight. 2. Possibly separate Table 12 into two tables, where for the higher end system; display and control of Flight ID and 4096 codes is minimum in flight.	Display of Flt ID and 4096 was made optional to help reduce overall costs.

198	CASCADE	A1.2.3.5.1. Table 12 also Table 14	A minimum LASE will not be able to indicate any Emergency. This limits the support to SAR use cases!	Consider cases for indication of emergency to support SAR use cases (see also other related CASCADE comment on 4096 code setting).	Ability to transmit 7700 'General Emergency' added, see para A1.2.3.1.3
199	CASCADE	A1.2.3.5.1. Table 12	Display of ICAO 24-bit address – consider prescribing octal or hexadecimal presentation.	See comment.	Typical format is Octal, Decimal, Hexadecimal
200	CASCADE	A1.2.5.3	The referenced requirement requires 125W for those with MOA above 15 000 feet or max cruise above 175kts. Is the intention that LASE may need to support 125W as a minimum ?	To be clarified.	Text changed
201	CASCADE	A1.2.5.4	Clarify that SIL shall be set "per hour"	" .. and the transmitted SIL shall be set to 1 (10-3 /hr)."	Text change

202	CASCADE	A1.2.5.6	Suggest re-wording for improved readability. Current text: NACp shall be derived from HFOM in accordance with RTCA DO-260B. Class B position sources may not provide HFOM directly. **HFOM shall be derived from Horizontal Dilution of Precision (HDOP) when HFOM is not available according to the following formula:** HFOM = 2 * HDOP * User Equivalent Range Error (UERE) where the (UERE) is 6 meters.	Updated text: NACp shall be derived from HFOM in accordance with RTCA DO-260B. Class B position sources may not provide HFOM directly. **When HFOM is not available directly, HFOM shall be derived from Horizontal Dilution of Precision (HDOP) according to the following formula:** HFOM = 2 * HDOP * User Equivalent Range Error (UERE) where the (UERE) is 6 meters.	Text changed
203	CASCADE	A1.2.5.8	Suggest re-wording for improved readability. Current text: Geometric Vertical Accuracy (GVA) shall be derived from Vertical Figure of Merit, (VFOM) in accordance with RTCA DO-260B. Class B position sources may not provide VFOM directly. **VFOM shall be derived from VDOP when VFOM is not available according to the following formula**: VFOM = 2 * VDOP * UERE where the UERE is 6 meters.	Geometric Vertical Accuracy (GVA) shall be derived from Vertical Figure of Merit, (VFOM) in accordance with RTCA DO-260B. Class B position sources may not provide VFOM directly. **When VFOM is not available directly, VFOM shall be derived from VDOP according to the following formula**: VFOM = 2 * VDOP * UERE where the UERE is 6 meters.	Text changed

204	CASCADE	(2nd) A1.2.5.7	"Optional ADS-B Out Capabilities" Section number should be A.1.2.6.	To be corrected (also for subsequent subsections).	Comment refers to A2.2.7. Text changed
205	CASCADE	A1.2.5.7 (i.e. A1.2.6)	General comment: The overview of the ADS-B Out data capabilities by introducing a table with mandatory capabilities (mainly data items) and recommended ones. For other capabilities, the TSO might express "shall not" requirements or be otherwise silent. In addition, the readability would be enhanced by grouping data items per BDS register – and by first clarifying which BDS registers are mandatory and which are recommended. One particular case is the question if BDS 6,2 is mandatory in support of squittering NACp, NICbaro, SIL (incl supplement), i.e. in addition to BDS 6,5.	In line with comment, first list mandatory BDS registers (i.e. 0,5; 0,8; 0,9 sub-type 1; 6,1 sub-type 1; 6,5 sub-type 0) and optional / recommended BDS registers (i.e. 0,6; 6,2 sub-type 1 if needed for quality indicator reporting; 6,5 sub-type 1). Add references to respective broadcast rate requirements Then, list mandatory capabilities / data items and optional / recommended ones (with reference to BDS register, as appropriate).	High level capability of LASE added to para A1.1.2
206	CASCADE	A1.2.5.7 (i.e. A1.2.6)	"Single Antenna Flag" and "NICbaro" Reporting capabilities (plus tests) to be added.	See comment.	Setting of Single antenna bit and NICbaro are not modified by this TSO and must be set in accordance with DO-260B

207	CASCADE	A1.2.5.7.1 Table 19	It is questioned if the optional squitter inhibit function is desirable, as it might be (inadvertently) be activated with undesired effects. In addition, Section A1.2.3.5 makes no reference to such function – which, indeed, should be obsolete as the power on / off switch should be referred to instead.	Consider removal of reference to optional squitter inhibit function.	Text changed. Reference removed
208	CASCADE	A1.2.5.7.1 Table 19	"AF" field in (military) DF=19.	Remain silent about this DF (or explicitly disallow it) .	Text changed. Reference removed
209	CASCADE	A1.2.5.7.1 Table 19	All entries for Airborne Velocity Messages should be deleted.	See comment, remain silent about these messages.	Text changed. Reference requiring this information added to A1.1.2
210	CASCADE	A1.2.5.7.1 Table 19	Target State & Status (BDS 6,2): TBD if required for horizontal position quality indicator reporting (in addition to BDS 6,5).	See comment, need for BDS 6,2 to be confirmed. If not, remain silent about this message.	Target State and Status information is considered optional since OEMs may decide to include this information on equipment with capabilities that exceed the minimum LASE requirements See A1.2.3.33
211	CASCADE	A1.2.5.7.1 Table 19	IDENT function should be added as an optional control element in A.1.2.3.5 (recommended for higher-end LASE solutions) – and should be mandatory from a data protocol perspective.	See comment, add to A1.2.3.5 and add to mandatory data transmission list in this section.	IDENT is used for separation services. LASE is not intended to be used routinely in controlled airspace and would add cost. This capability is considered optional, see para 1.2.3.1.6
212	CASCADE	A1.2.5.7.1 Table 19	Type Code 24 shall not be transmitted (for use by ground MLAT systems)	See comment (at least remove from list).	Text changed. Reference removed

213	CASCADE	A1.2.5.7.1 Table 19	4096 code support is listed as optional in Table 19 but not in other requirements in LASE.	Remove 4096 codes from table 19.	Text removed
214	CASCADE	A1.2.5.7.1 Table 19	Type Code 23 should not be transmitted (obsolete legacy test message)	See comment (remain silent about TC 23).	Text changed
215	CASCADE	A1.2.5.7.1 Table 19	Last entry: to be treated in line with TBD on BDS 6,2 squittering altogether.	Retain / delete as appropriate.	Text removed from table.
216	CASCADE	A1.2.5.8	Simplify by stating that BDS 6,1 sub-type 2 shall not be transmitted by LASE class A equipment altogether.	See comment.	Text changed

217	CASCADE	A1.2.6.2	There may be a risk of misinterpretation that the position solution may not be SBAS augmented. Current text: The GNSS position source shall provide a GPS only solution for use by the LASE ADS-B function. The FAA has not evaluated the performance of other GNSS systems for use in support of aviation intended functions. This TSO will be updated once sufficient analysis has been done to show that other GNSS are appropriate for use by LASE.	Suggested text: The GNSS position source shall provide a GPS only solution (1) for use by the LASE ADS-B function. The FAA has not evaluated the performance of other GNSS systems for use in support of aviation intended functions. This TSO will be updated once sufficient analysis has been done to show that other GNSS are appropriate for use by LASE. Add note (1): GPS only solution refers to the use of the GPS satellite constellation, it does not exclude augmentation of the GPS solution, such as provided by SBAS or GBAS systems.	A modified version of the suggested change was made

218	CASCADE	A1.2.6.4	Whilst the requirement makes reference to detecting step errors of 700m (NB: DO-229D specifies a 750m test stimulus), the test pass condition (A2.2.6.4.1.1) refers to 0.5 NM (NB: the DO-229D criterion is 200 meters). The rationale for the very conservative 0.5 NM test pass criterion should be explained, as the actual performance should be rather (well) within the DO-229D 200 m criterion. Ideally, reference should be made to the DO-229D 200 m criterion. At least a note should be added to say that actual performance is expected to be much better than 0.5 NM.	See comment.	Text changed
219	CASCADE	A2.2.5.4	Add correct transmission of respective NIC and SIL supplements.	See comment.	Text changed. Comment addressed by previous comment

220	CASCADE	A2.2.5.7 (i.e. A2.2.6)	Respective comments on A1.2.5.7 (i.e. A1.2.6) apply throughout, i.e. with respect to the deletion of the testing of capabilities that should be allowed or that should not be mentioned in this TSO. Correct section numbering.	See comment.	Text changed
221	CASCADE	A2.2.6	Overall comment: some tests refer to satellite signal power of -134 dBm and some to -128 dBm.	Rationale to be added.	Text added to para A2.2.6.4 stating this test is not sensitive to power
222	CASCADE	A2.2.6.3.1.1	It is understood that the TSO can only refer to a representative antenna. This bears the question (also with respect to an LASE installation overall), in which document respective guidance will be provided (incl. on obtaining and checking 24-bit addresses).	See comment.	Advisory Circular guidance is planned. This comment will be incorporated into the LASE AC guidance.
223	CASCADE	A2.2.6.3.1.2	Pass criterion for vertical error to be added.	See comment.	Text changed. An accuracy of better than 45 meters was added
224	CASCADE	A2.2.6.3.2.3	Pass criterion for vertical error to be added.	See comment.	This para requires the test to show valid position reports 99.9% of the time
225	CASCADE	A2.2.6.3.2.4.1.4 & A.2.2.6.7.1.6	Reference to “approved models” for atmospheric ranging error effects to be added.	See comment.	Text changed, see paras A2.2.6.3.3.4.5 A2.2.6.7.2.6 A2.2.6.8.2.2.8 A2.2.6.9.2.7.

226	CASCADE	A2.2.6.8.1.1.3	What is rationale for an HDOP of 5.0 ? It is noted that even with a 24-satellite constellation, this condition might be difficult to create.	Clarify reference to an HDOP of 5.0.	Given a full constellation a commercial chip might perform well even without SBAS. In order to make this test more stressing, we want to depopulate the constellation and see what happens.
227	CASCADE	A2.2.6.8.1.1.6.3	Why limit the ramp error to 2000m? It should be larger (e.g. 10 000m) to make sure that the test pass criterion is met (horiz. Position error not exceeding 0.5 NM) for such errors as well.	See comment.	There is no need to watch for more than 2000 meters. In the tests we conducted, poor performance is visible far before it reaches that point.
228	CASCADE	A2.2.6.9.2.2	Should the pass/fail criteria not be the same as in A2.2.6.8.1.2.3 ?	See comment.	Text changed
229	CASCADE	A3.4	Why is the pass/fail criteria shall placed in a note?	Make it plain text.	Text changed

230	John Ferrara	Sec 1 Purpose 1st para	Does not address ATC seeing LASE transponder or seeing LASE ADS-B out. It is desirable for ATC to see LASE as there will be many aircraft without ADS-B IN and without TAS/TCAS traffic detection. This will occur both inside and outside ADS-B rule airspace. What additional requirements (if any) would be needed for LASE equipped aircraft to receive ATC (VFR or IFR) services such as traffic advisories outside of ADS-B rule airspace? This capability would be a benefit to the user and might be an incentive for voluntary equipage.	Suggest clarifying how LASE fits into the existing ATC surveillance system. Address the issue of ATC seeing LASE in detail so the limitations are understood. Also address if the ground ADS-B system will provide TIS-B or ADS-R service based on LASE.	By definition, LASE equipment does not meet the requirements needed to fly in rule airspace. As such the unit cannot be used as the basis for separation services. Airmen wanting the benefits that come with the capability to be seen by ATC should install a rule compliant transponder or ADS-B device.
231	John Ferrara	Sec 1 Purpose 1st bullet	Possible use by parachutists should be discussed		TSO is silent on the use of LASE by parachutist due to concerns about the size of a portable unit with its associated power supply as well as the ability of a system to be worn in very close proximity to the body (see Appendix 4).
232	John Ferrara	Sec 1 Purpose 2nd bullet	91.215 (b) does not specifically mention TSO C74c	For clarity change 91.215(b) to 91.215 (a) or to just 91.215	Removed subparagraph references and last bullet.
233	John Ferrara	Sec 1 Purpose 2nd bullet	91.225 (b) is just for below 18K	For clarity change 91.225 (b) to 91.225 (a) & (b) or just 91.225	Removed subparagraph references and last bullet.

234	John Ferrara	Sec 1 Purpose 3rd bullet	Non electrical aircraft can operate in some ADS-B/transponder airspace without prior permission and should still be able to operate in this airspace without prior permission if LASE is installed. Wording might be interpreted to mean LASE must be off if permission not obtained.	Clarify that from an airspace regulatory point of view (91.215 and 91.225) having LASE is the same as being unequipped and there are no additional airspace entry privileges gained in this airspace with LASE. Clarify that LASE is intended to always be on in all airspace.	Text changed. Removed last bullet.
235	John Ferrara	Sec 1 Purpose 8th bullet	If an ADS-B client aircraft is only UAT ADS-B IN equipped is ADS-R service provided for LASE equipped targets? If target aircraft LASE GPS data is bad will TIS-B service be provided to client aircraft based on LASE transponder output? Will LASE equipped aircraft always be accepted as Clients for TIS-B/ADS-R? Will LASE data be sent to ATC?	Clarify what the ground radars and ADS-B IN equipped (UAT or 1090) will see and the services provided based on LASE data. Clarification should also include case where LASE ADS-B out is good but LASE transponder out is not (failed pressure altitude but good GPS altitude for example).	Added a sentence to section 3a
236	John Ferrara	Sec 1 Purpose	There are many passive transponder detectors in use. Response of these to LASE is not mentioned.	Clarify if passive transponder detectors will see LASE equipped aircraft.	Passive Traffic devices may work with LASE, but FAA cannot guarantee that. Passive Traffic devices were certified without a standard and we have no basis to make this determination.

237	John Ferrara	Sec 3 Requirements	1st para says LASE "may not support SSR.." Sec 3a says LASE "not required to reply to ground sensors"	Suggest clarifying which technical sections of LASE TSO prevent always responding to ground sensors or what minimum technical sections need to be added to always respond to ground sensors. This would make easier reading for the reader not fully familiar with transponder/SSR requirements.	Text changed. Text expanded, the word "will" is used.
238	John Ferrara	Sec 3(a) Functionality	Para states LASE must include both Class A and Class B equipment. Appendix A1.2.5.4 indicates TSO certified GPS can be used in place of Class B equipment. Are there any benefits to using a TSO'd GPS? What would be the integration/installation requirements if certified TSO GPS is used?	Clarify requirement.	Installation guidance will be provided via Advisory Circular. Current plan is to add material to AC 20-165A. TSO text is just to clarify that although manufacturers can receive TSO independently, a complete install must include both. AC guidance will elaborate on mixing and matching LASE equipment and certified equipment.
239	John Ferrara	Sec 3(a) Functionality	ADS-B in would be a benefit to the user which might encourage equipage. LASE TSO requires ADS-B in meet TSO which will increase costs.	Suggest allowing a non-TSO (no technical or environmental requirements) ADS-B implementation to be built into LASE with no certification requirements. Could be an audio alert only implementation or an output to a tablet/ipad.	Text indicates that ADS-B IN functionality SHOULD meet the ADS-B IN TSO performance.

240	John Ferrara	Sec 7 Furnished data	Data does not always get to the end user (aircraft owner or pilot)	Clarify this wording to make it clear data must be available to the end user.	Text consistent with Order 8150.1C Technical Oder Standard Programs
241	John Ferrara	A1.1 Introductio n	See comments to sect 1 above		A1.1 modified consistent with Section 1
242	John Ferrara	A1.2.7.1-A1.2.7.3	An integrated antenna is likely to have significant degradation from an external antenna. Rigorous antenna requirements are likely to drive costs up.	Provide more guidance on what will be acceptable for integrated or portable internal antennas. Allow very reduced antenna performance to lower certification and installations costs.	Softened antenna section to allow vendors to provide antennas that do not meet the TSO standards.
243	John Ferrara	A1.2.8.1 Sharing LASE between airframes	Pilot/owner removing and reinstalling transponders or encoders is not permitted by part 45. Also after breaking the static port a retest is required (91.411(a2). This imposes costs which will limit implementation. Will the every two year test of 91.411 & 91.413 be exempt?	Clarify if LASE installations will be exempt from any of these regulations? Allow LASE with an altitude source not connected to the aircraft static system. Allow a completely portable system. Clarify the installation approval requirements and process.	The Part 43 transponder check does not apply to TSO-C199. The regulation 14 CFR 91.413 does not call out TSO-C199 so there is no need to document this.

244	John Ferrara	A1.2.8.2 Power Consumption	[1] The targeted users (aircraft exempt from carrying a transponder) are by regulation aircraft without engine driven electrical system so some sort of battery power must be provided. Battery requirements such minimum operating time, installed or portable power source safety are not addressed. Power source installation approval requirements could have a significant cost impact. [2] Will LASE installation in aircraft with electrical systems be allowed for use outside ADS-B airspace? LASE might be a low cost way for aircraft to become an ADS-B client and receive traffic (ADS-R and TIS-B).	Address this issue. Would installed LASE but with a portable power source be allowed?	1 - Battery power is addressed by other rules and regulations. The LASE TSO is silent on this issue since battery requirements are in review. Manufactures will need to follow battery requirements at time of production 2 - Aircraft with electrical systems operating in rule airspace will need to follow 91.215 and 91.225. LASE may be designed to operate off of aircraft power for installations operated outside of rule airspace.

245	Accord	3.a	**Original Text** **“**Class A LASE equipment includes the transponder, altitude source, and ADS-B Out functionality. Class 1 LASE equipment includes the Global Navigation Satellite System, (GNSS), position source functionality.**”** **Comments** A new Class such as Class C could be defined that will have some level of integrity for the position source such that SIL could be set to 2 (10e-5).	Introduction of a new Class for the position source	At this time, including a GNSS class to support SIL=2 is not defined by the TSO. Additional industry development will be required to define requirements for GNSS receiver supporting SIL=2.

246	Accord	3.a.(3)	**Original Text** "The ADS-B Out function must meet a subset of the requirements found in RTCA, Inc. document RTCA/DO-260B, *Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)"* **Comments** Currently the draft TSO does not provide UAT Out as per RTCA/DO-282B as an option for ADS-B Out, even though it states that the LASE device should be capable of working with aircraft fitted with TSO-C154c equipment	UAT Out as per RTCA/DO-282B may be given as one of the options for ADS-B Out in this TSO Even though it might be argued that today FAA has NOT mandated UAT In as per RTCA/DO-282B, it is anticipated that in the near future a lot of aircraft may be fitted with ADS-B In/Out equipment as per RTCA/DO-282B if cost barrier for ADS-B In is insignificant	LASE is designed to interoperate with TAS and TCAS II systems so it must transmit on 1090MHz. UAT capabilities may be added as optional features.

247	Accord	5.a.(5)	**Original Text** "A summary of the test conditions used for environmental qualifications for each component of the article. For example, a form as described in RTCA/DO-160G," **Comments** It refers to DO-160G, whereas earlier it referred to DO-160D	DO-160 Version number may be made consistent	Text changed
248	Accord	A1.2.5	**Original Text** "UERE = 6 meters" **Comments** UERE = 6.1 meters to make it consistent with DO-229D	UERE may be made 6.1 m to keep it consistent with DO-229D	Text changed

249	Accord	A1.2.5.4	**Original Text** "When LASE is installed with a position source meeting the Class B requirements of this TSO and transmitting a valid position, the transmitted NIC shall be set to 6 (0.5 NM) and the transmitted SIL shall be set to 1 (10-3)." **Comments** A new Class such as Class C could be defined that will have some level of integrity such that SIL could be set to 2 (10e-5).	Introduction of a new Class for the position source	At this time, including a GNSS class to support SIL=2 is not defined by the TSO. Additional industry development will be required to define requirements for GNSS receiver supporting SIL=2.

250	Accord	A1.2.6.1	**Original Text** "Manufacturers may use commercial off the shelf (COTS) GNSS position sources to meet the performance of this ….. Refer to RTCA DO-229D when interpreting SBAS related requirements." **Comments** Inclusion of integrity to a commercial (COTS) GNSS will provide enhanced safety. We believe this integrity will enhance the capability and scope of use of the commercial (COTS) GNSS. Indications are that there is non-USA NASP support for the integrity enhancement. While the USA NAS would benefit from enhanced GNSS integrity, there should at least be another category such as Class C of LASE GNSS source with such integrity such that SIL could be set to 2. The other parameters (NIC, NACp, SDA, NACv, GVA) will remain the same as defined in the Draft.	Manufacturers may also produce a LASE variant using a commercial GNSS with integrity meeting SIL = 2.	At this time, including a GNSS class to support SIL=2 is not defined by the TSO. Additional industry development will be required to define requirements for GNSS receiver supporting SIL=2.

251	Accord	A1.2.6.2	**Original Text** "The GNSS position source shall provide a GPS only solution" **Comments** The GNSS position source shall provide a GPS only or GPS-SBAS solution	Perhaps text is modified to say "The GNSS position source shall provide a GPS-SBAS or GPS-only solution" Several other places GPS only position is referred, which should be GPS only or GPS-SBAS solution (example: A2.2.6.2). Also, it might be specifically stated that if a receiver is capable of providing combined solution using GPS and other constellations, then for the LASE applications, the receiver shall be set to work using GPS-SBAS mode only. Measurements from other constellations shall not be used in the position and velocity solution.	Text changed. Clarification added to the end of para A1.2.6.2. text added to para A2.2.6.2

252	Accord	A1.2.6.6 A2.2.6.6.1.1	**Original Text** "The GNSS position source shall not transmit false or misleading data in the presence of broadband interference. There is no minimum interference rejection requirement for LASE equipment and loss of position in the presence of interference is acceptable behavior." "The interfering signal shall be broadband noise with bandwidth of 20 MHz centered on 1575.42 MHz. The initial power spectral density shall be -170.5 dBm/Hz (-97.5 dBm total power). **Comments** Perhaps the interference requirements and corresponding tests could be defined with respect to CW interference instead of broadband interference	Replace broadband interference by CW interference at 1575.42 MHz. Also, modify the test procedure accordingly.	Test sufficient as written. No change.

253	Accord	A1.2.7.1	**Original Text** "The requirements for GNSS antennas are specified in TSO-C145, and TSO-C146. The antennas should be designed to meet the performance specified in the applicable TSO." **Comments** All COTS receivers work with commercial antennas that cost less than $10. None of these antennas will meet the antenna requirements specified in C145/146. Also, none of the TSO antenna is in-built into the GNSS receiver	No specific requirement for the GPS antenna may be spelt out. This TSO may only define the requirement of the GNSS receiver as a system, including antenna, and not separate requirement for antenna. The 24-hour accuracy test shall be using the antenna that will be used in the aircraft installation	Text modified.
254	Accord	A2.2.6	In case another category such as Class C position source with SIL = 2 is defined, then additional test procedures for this new category are to be defined	Include additional test procedure on the COTS receiver with integrity functions to ensure SIL = 2.	At this time, including a GNSS class to support SIL=2 is not defined by the TSO. Additional industry development will be required to define requirements for GNSS receiver supporting SIL=2.

255	Garmin	1	In the "LASE will enable an aircraft to be visible to other aircraft equipped with:" list, the last two items start with "Aircraft equipped with" and "Aircraft with". This text is redundant with the text in the sentence introducing the list.	Remove "Aircraft equipped with" from the 4th item in the list. Remove "Aircraft with" from the 5th item in the list.	Text changed
256	Garmin	3.a	Includes the statement: **Class A** LASE equipment includes the transponder, altitude source, and ADS-B Out functionality. **Class 1** LASE equipment includes the Global Navigation Satellite System, (GNSS), position source functionality. Elsewhere in the document the LASE equipment which includes the Global Navigation Satellite System, (GNSS), position source functionality is referred to as **Class B** equipment	Select alpha or numeric for equipment classes and stay consistent	Text changed

257	Garmin	3.a.(2)	Paragraph 3.a.(2) states "The altitude source functionality must meet the requirements of TSO C88b, *Automatic Pressure Altitude Reporting Code-Generating Equipment*, dated February 6, 2007." It is unlikely that aircraft without electrical systems will have a TSO-C88b pressure altitude encoder installed. Requiring such aircraft to purchase and install a TSO-C88b pressure altitude encoder could result in yet another reason why LASE equipment may not be successful in the marketplace.	Reconcile whether the required altitude source function must meet TSO-C88b pressure altitude requirements or whether GPS vertical position information is sufficient.	LASE must use a certified altitude source to ensure it works with TAS and TCAS equipment. Certified altitude source are not a significant cost driver for LASE.
258	Garmin	3.a.(4)	TSO paragraph 3.a.(4) allows the use of commercially available position sources, but the requirement for the use of SBAS precludes the use of TSO-C129a and TSO-C196 receivers. These receivers may otherwise be suitable for use as a class B position source as they include FDE capability to detect and reject GPS signal in space errors.	Consider allowing use of TSO-C129a or TSO-C196 receivers as position sources.	Installation with certified GPS will be addressed in the Advisory Circular.

259	Garmin	3.b.	TSO paragraph 3.b states that the failure of the function defined in paragraph 3.a is a minor failure condition. It is unclear whether this applies only to Class A equipment or if it applies to both Class A and B equipment. Subsequent paragraphs of this TSO (3.d, 3.e, 3.f) exempt Class B equipment from certain qualification activities. It's not clear what additional qualification data, if any, is needed to show compliance with a Minor failure classification. TSO paragraph 3.a.(4) states that the intent of the TSO is to allow use of commercially available GNSS position sources provided that they meet the requirements in Appendix 1. Commercially available GNSS position sources are unlikely to be designed commensurate with a minor failure condition classification.	Clarify intent of TSO paragraph 3.b. with respect to Class B equipment.	Modified text

260	Garmin	3.b	Includes the statement: Design the system to at least this failure condition classification. Wording needs to change to recognize the fact that failure condition classification is ultimately determined by aircraft level analysis. It is reasonable to clarify the wording to ensure aircraft level analysis is the driver for determining failure classifications. EASA has recognized this using the following wording in ED Decision 2010/010/R 14/12/2010 Annex I Subpart A – General 2.4 Failure condition classification: "Develop the system to, at least, the design assurance level equal to the failure condition classifications provided in the ETSO. Development to a lower Design Assurance Level may be justified for certain cases and accepted during the ETSO process but will lead to installation restrictions."	Re-work this section to match the EASA wording. Or work with industry to develop an agreed to wording.	Aircraft level safety analysis cannot justify lowering the criticality of surveillance functions to the NAS.

261	Garmin	4.a	Includes the statement: The marking must include the serial number and functional equipment class in accordance with paragraph 3. The Order 8150.1C TSO template does not include the "applicable equipment class(es)" phrase. Garmin is routinely granted deviations from TSO requirements to mark the "applicable equipment class(es)" as the equipment does not have sufficient space to include this as well as all other required markings (e.g., multiple TSOs and SW level, etc. that appear in other TSOs). This deviation is granted through use of a marking similar to the example in Order 8150.1C ¶ 7-4.e.(4).(b) "See Inst Mnl for Addtl TSO approvals and/or markings.").	Remove "and functional equipment class in accordance with paragraph 3" from the quoted text. Add a new paragraph under 5.a requiring the equipment class(es) to be included in the "Manual(s)".	Text consistent with Order 8150.1C Technical Oder Standard Programs

262	Garmin	4.b.(2)	Paragraph 4.b.(2) states: Each subassembly of the article that you determined may be interchangeable. This language is confusing. The language for this requirement is confusing. This could mean that a stuffed printed circuit board needs the TSO number.	Suggest removing the statement or if removing causes problems, work with industry to establish wording that is better understood.	Text consistent with Order 8150.1C Technical Oder Standard Programs

263	Garmin	5.a.(4)(d)	This paragraph requires listing the "failure condition classification" in the installation manual which can be misleading to the installer and is inconsistent with the process of determining failure condition classification at the aircraft level. Failure condition classification is determined by system safety assessment at the aircraft level and can vary based on installation. By providing a failure condition classification at the appliance level this creates an impression that the safety analysis for these functions is complete. Additionally, TSO paragraphs 5.a.(4)(a) and 5.a.(4)(b) already require the Manual(s)to contain the software and AEH design assurance levels that an installer needs to determine whether the equipment can support the aircraft level failure condition classification.	Remove the requirement to list "failure condition classification" in the Manual(s).	Text consistent with Order 8150.1C Technical Oder Standard Programs

264	Garmin	5.c	TSO paragraph 5.c states "If the article includes software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary" But, paragraph 3.e states "Class B equipment is exempt from software qualification." So, paragraph 5.c is not applicable to Class B equipment.	Clarify paragraph 5.c to be consistent with paragraph 3.e.	Text changed.
265	Garmin	5.d	TSO paragraph 5.d states "If the article includes complex custom airborne electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable)." But, paragraph 3.f states "Class B equipment is exempt from electronic hardware qualification defined in this paragraph." So, paragraph 5.d is not applicable to Class B equipment.	Clarify paragraph 5.d to be consistent with paragraph 3.f.	Text changed

266	Garmin	5.f	TSO paragraph 5.f and its subparagraphs include definition of non-TSO functions and the data to be submitted to the ACO for non-TSO functions. This guidance is inconsistent with Order 8110.4C CHG 4. TSO paragraph 5.f states "Identify functionality or performance contained in the article not evaluated under paragraph 3 of this TSO (that is, non-TSO functions)." Use of the term "performance" in the definition of a non-TSO function is inconsistent with the Order 8110.4C CHG 4 paragraph 6-9.b.(1) and 6-9.b.(3)(a) guidance regarding how to define a non-TSO function. The issue is non-TSO should not be defined as "performance". It will create difficulty if these criteria are used. For example, if a TSO requires a minimum 10 watt transmitter and a company makes equipment that is robust at 11 watts, the performance exceeding the TSO is not called out under the TSO; consequently, by the paragraph 5.f "performance" definition, the 11 watt transmitter has a non-TSO 1 watt	Adjust the wording in the TSO (template) to be consistent with the 8110.4C CHG 4 intent.	Text consistent with Order 8150.1C Technical Oder Standard Programs

267	Garmin	6.g	TSO paragraph 6.g states "If the article includes software, the appropriate documentation defined in RTCA/DO 178B, Process Objectives and Outputs by Software Level, including all data supporting the applicable objectives in RTCA/DO 178B Annex A." But, paragraph 3.e states "Class B equipment is exempt from software qualification." So, paragraph 6.g is not applicable to Class B equipment.	Clarify paragraph 6.g to be consistent with paragraph 3.e.	Text in para 6 g changed to clarify applicability to Class B equipment

268	Garmin	7.b	TSO paragraph 7.b contains wording that is inconsistent with Order 8110.4C CHG 4. TSO paragraph 7.b includes additional guidance about what furnished data should be provided to an operator or repair station when the equipment includes a non-TSO function. The problematic guidance states "include one copy of the data in paragraphs 5.f.(1) through 5.f.(4)." This guidance is inconsistent with Order 8110.4C CHG 4. Order 8110.4C CHG 4 paragraph 6-9.b.(6) defines the FAA-industry agreed data that must be provided to an installer when equipment includes a non-TSO function.	Adjust the wording in the TSO (template) to be consistent with the 8110.4C CHG 4 intent.	Text consistent with Order 8150.1C Technical Oder Standard Programs
269	Garmin	A1.1	In the "LASE will enable an aircraft to be visible to other aircraft equipped with:" list, the last two items start with "Aircraft equipped with" and "Aircraft with". This text is redundant with the text in the sentence introducing the list.	Remove "Aircraft equipped with" from the 4th item in the list. Remove "Aircraft with" from the 5th item in the list.	Text changed

270	Garmin	A1.2.3.1	Per DO-181E section 1.4.3, a level 2 transponder supports many capabilities that are obviously not intended to be supported by this equipment.	Clarify the level 1 and level 2 capabilities to be provided by the LASE equipment.	Text changed. LASE classes have been clarified Section A1.2.3 significantly rewritten to provide more detailed description of transponder capabilities
271	Garmin	A1.2.3.5.6	A means of initiating the IDENT (SPI) feature is recommended, but it is unclear why this would be recommended for equipment that does not respond to Mode A interrogation. Perhaps it is meant to support the SPI subfield in the ADS-B Operational Status Message.	Clarify why the means of initiating the IDENT (SPI) feature is recommended.	Text changed. This capability is recommend at the request of other Aviation Service Providers (ASP)

272	Garmin	A1.2.4.1	Paragraph A1.2.4.1 states "The altitude source function must meet the requirements of TSO-C88b, *Automatic Pressure Altitude Reporting Code-Generating Equipment*, dated February 6, 2007. It is recommended that the altitude source provide 25 foot or better resolution." It is unlikely that aircraft without electrical systems will have a TSO-C88b pressure altitude encoder installed. Requiring such aircraft to purchase and install a TSO-C88b pressure altitude encoder could result in yet another reason why LASE equipment may not be successful in the marketplace.	Reconcile whether the required altitude source function must meet TSO-C88b pressure altitude requirements or whether GPS vertical position information is sufficient.	LASE must use a certified altitude source to ensure it works with TAS and TCAS equipment. Certified altitude source are not a significant cost driver for LASE.
273	Garmin	A1.2.5.2	Table 18 references DO-181E. It should reference DO-260B instead.	Change DO-181E to DO-260B.	Text changed

274	Garmin	A.1.2.6.1	TSO paragraph A.1.2.6.1 states: “The position source must be capable of using Satellite-Based Augmentation System (SBAS) corrections and health messages to detect and correct satellite range errors.” This provides no option for using TSO-C129 or TSO-C196 receivers as the GNSS position source. Receivers certified under either TSO provide sufficient integrity and design assurance to meet the intended function without the use of SBAS signals.	Allow the use of TSO-C129a or TSO-C196 position sources.	Text changed

275	Garmin	A.1.2.6.3	TSO paragraph A.1.2.6.3 states: “The GNSS position source should transmit horizontal position measurements more accurate than 30 meters.” This accuracy specification is not stated as a requirement (“should” rather than “shall”) and it is not associated with a probability (i.e. 95% of the time under fault free conditions). AC 20-165A Appendix 2 section 3.c. uses a 95% probability level under fault free conditions. None of the tests specified in Appendix 2 include checks for this 30m accuracy level. It is unclear what, if any, verification is required to demonstrate the 30m accuracy level.	If the 30m horizontal accuracy is a requirement, modify text to include a “shall” statement and provide an associated probability (i.e. 95% of the time under fault free conditions) If the 30m horizontal accuracy level is a requirement, modify tests in A.2.2.6.3 to check for this accuracy level. If the 30m horizontal accuracy level is not a requirement, then clarify its intended purpose.	Text changed

276	Garmin	A.1.2.6.5	TSO paragraph A.1.2.6.5 states: “The GNSS position source shall transmit horizontal velocity measurements more accurate than 10 m/s.” Similar to the comment on paragraph A.1.2.6.3, this requirement does not provide an associated probability level (i.e. 95% of the time under fault free conditions). The test procedures referenced in Appendix 2 of this TSO are based on an assumption of a 95% probability under fault free conditions.	Modify the requirement to state that associated probability is 95% under fault-free conditions.	Text modified.

277	Garmin	A.1.2.6.10	TSO paragraph A.1.2.6.10 states: "The GNSS position source should transmit geometric altitude, Height Above the Ellipsoid (HAE), measurements more accurate than 45 meters." Similar to the comment on paragraph A.1.2.6.3, this specification is not stated as a requirement ("should rather than "shall") and it is not associated with a probability (i.e. 95% of the time under fault free conditions). AC 20-165A Appendix 2 section 3.c. uses a 95% probability level under fault free conditions. None of the tests specified in Appendix 2 include checks for this 45m vertical position accuracy level. It is unclear what, if any, verification is required to demonstrate the 45m vertical position accuracy level.	If the 45m vertical accuracy is a requirement, modify text to include a "shall" statement and provide an associated probability (i.e. 95% of the time under fault free conditions) If the 45m vertical accuracy level is a requirement, modify tests in A.2.2.6.3 to check for this accuracy level. Additionally, reconcile whether the required altitude source function must meet TSO-C88b pressure altitude requirements (see related comments on paragraphs 3.a.(2) and A1.2.4.1) or whether GPS vertical position information is sufficient. If the 45m vertical accuracy level is not a requirement, then clarify its intended purpose.	Text changed. Test Text changed appropriately.

278	Garmin	A.1.2.6.10	TSO paragraph A.1.2.6.10 states: "The GNSS position source shall either transmit a Vertical Figure of Merit (95%) (VFOM) or a Vertical Dilution of Precision (VDOP) metric." It is not clear why the output of a vertical accuracy metric is a minimum requirement. AC 20-165A Appendix 2 sections 3.d and 4.o state that the position source **should** provide a vertical figure of merit output, but it is not a minimum requirement for ADS-B out compliance. Similarly, none of the GPS receiver TSOs (C145, C146, C196, and C129) require the output of a vertical accuracy metric. Paragraph 3.a.(2) of this TSO requires that the equipment provide pressure altitude reporting. This also argues against making geometric vertical accuracy a minimum requirement.	Reconcile whether the required altitude source function must meet TSO-C88b pressure altitude requirements (see related comments on paragraphs 3.a.(2) and A1.2.4.1) or whether GPS vertical position information is sufficient. If the VFOM or VDOP metric is not a requirement, then change the "shall" to "should" for this requirement to be consistent with other published guidance and clarify its intended purpose.	Intentionally different from ADS-B Rule. Requirements based on LASE use case.

279	Garmin	A.1.2.7.1	TSO paragraph A.1.2.7.1 states: "The requirements for GNSS antennas are specified in TSO-C145, and TSO-C146." GPS antenna requirements are contained in TSO-C144 and TSO-C190, not in TSO-C145 and TSO-C146.	Reference TSO-C144 and TSO-C190 for antenna requirements.	Text changed.
280	Garmin	A.1.2.7.1	TSO paragraph A.1.2.7.1 states that the GNSS antenna **should** meet the requirements of the applicable TSO (TSO-C144 or TSO-C190), which implies that this is not a minimum requirement. However, the paragraph further states that any antenna performance degradation must be approved via the deviation process. This seems excessive given that the antenna TSOs are not minimum requirements for this equipment. TSO compliant GPS antennas are significantly more expensive than the antennas typically used with commercial grade GPS chipsets.	Do not require TSO deviations for the use of GNSS antennas that are not designed to TSO-C144 or TSO-C190.	Text Changed

281	Garmin	A.2.2.6.1	Typographic error	Change “to including” to “to include”	Text changed
282	Garmin	A.2.2.6.3.1.1	The pass criteria specified for the 24 hour accuracy test do not verify the 30m horizontal accuracy specification in section A.1.2.6.3 of this TSO.	If the 30m horizontal accuracy level is a requirement, it should be included in this test. Verify that the horizontal position error is less than 30m for 95% of the valid position reports.	Text changed
283	Garmin	A.2.2.6.3.1.1	The pass criteria specified for the 24 hour accuracy test do not verify the 45m vertical accuracy specification in section A.1.2.6.10 of this TSO.	If the 45m vertical accuracy level is a requirement, it should be included in this test. Verify that the vertical position error is less than 45m for 95% of the valid position reports.	Text Changed
284	Garmin	A.2.2.6.3.2.2	The pass criteria specified for the simulator based accuracy tests do not verify the 30m horizontal accuracy specification in section A.1.2.6.3 of this TSO.	If the 30m horizontal accuracy level is a requirement, it should be included in this test. Verify that the horizontal position error is less than 30m for 95% of the valid position reports.	Text Changed
285	Garmin	A.2.2.6.3.2.2	The pass criteria specified for the simulator based accuracy tests do not verify the 45m vertical accuracy specification in section A.1.2.6.10 of this TSO.	If the 45m vertical accuracy level is a requirement, it should be included in this test. Verify that the vertical position error is less than 45m for 95% of the valid position reports.	Text Changed

286	Garmin	A.2.2.6.9.1.2	The simulator scenario described includes long term corrections at the "standard" update rate. No guidance is given for the "standard" long term correction update rate. RTCA/DO-229D defines a maximum update interval of 120 seconds for long term corrections.	Clarify what rate should be used for long term corrections.	Text changed. Section rewritten
287	Garmin	A.2.2.6.9.1.6.1	Introducing a 1000m bias error in the simulated GPS signals will trip the step detector function causing the receiver to exclude the satellite without applying any SBAS corrections The step detector function is tested elsewhere and including a bias of this magnitude defeats the purpose of the test.	Either use a much smaller bias error (significantly smaller than 700 meters) or eliminate the bias error altogether.	Text changed. Section rewritten

288	Garmin	A.2.2.6.9.2.2	The pass criteria for this test compare the horizontal and vertical position errors against the HFOM and VFOM accuracy metrics, respectively. It is unlikely that a commercial grade GPS sensor will inflate the HFOM and VFOM values to reflect the SBAS UDREI data broadcast in the SBAS message. This means that the horizontal and vertical position errors can be expected to exceed HFOM and VFOM until the fast and long term correction messages are received to correct the injected ramp and bias errors. Long term corrections are broadcast at a slower rate than fast corrections. The delay in receiving long term corrections will likely increase the number of position measurements that exceed HFOM/VFOM. Additionally, the pass/fail criteria for this test do not include an absolute accuracy limit of 0.5 NM as is done in the step detector and ramp error tests.	Change the pass/fail criteria to either: • Allow the position errors to exceed HFOM and VFOM until the fast and long term corrections are sent to the receiver; OR • Eliminate the comparison against HFOM and VFOM altogether Add a check that the horizontal position error is less than 0.5 NM for all valid position reports received after the reception of fast and long term data that corrects the injected ramp and bias errors.	Text changed. Section rewritten

289	Garmin	A.3.2	TSO paragraph A.3.2 states: "The following test procedures must be run when subject to DO-160E Environmental Test Section 4, Temperature and Altitude, and Section 5, Temperature Variation Testing" It is unclear from this statement if the intent is that Class B equipment only needs to be subjected to DO-160E section 4 and 5 tests. No test procedures are specified for other environmental conditions.	Clarify the set of environmental conditions that must be evaluated for Class B equipment.	Text changed
290	Enigma Avionics Pty Ltd	paragraphs 3a and related 3e & 3f	The definitions of Class A & Class B in paragraph 3a could maybe be clearer. Class A = transponder, altitude source and ADS-B Out (but not GNSS?) ? Class B = GNSS position source (only ?) ? OR Is it intended that Class B = transponder, altitude source, ADS-B Out <u>with</u> integral GNSS position source ?		Text changed to clarify Classes of equipment

291	Enigma Avionics Pty Ltd	2. Paragraph 3e., Software Qualification	The paragraph specifically mentions "Class B equipment is exempt from software qualification defined in this paragraph" however is silent on the Class A equipment.		Text changed
292	Enigma Avionics Pty Ltd	3. Paragraph 3f.,	Hardware Qualification. The paragraph specifically mentions "Class B equipment is exempt from hardware qualification defined in this paragraph" however is silent on the Class A equipment.		Text changed
293	Air Services Australia	General	Support the use of ADS-B Type Code 31 sub-type 0 message bits to identify LASE equipment type as recently presented to the ICAO Aeronautical Surveillance Panel Working Group 16 Meeting in paper WP ASP16-26	Expand what was proposed in WP ASP16-26 to the following (or similar): 0 0 Non-LASE Equipment 0 1 Non-certified LASE Equipment 1 0 Certified LASE with commercial GNSS 1 1 Certified LASE with certified GNSS	It is unclear what the additional bit definitions would be used operationally. At this point we plan to only use a single bit to indicate LASE Class A or B equipment is installed.

294	Air Services Australia	General	The identification of Non-certified LASE equipment (see previous comment) allows for production of equipment that has been verified to meet the required performance, as described in the TSO but has not met all conditions for issue of certification (TSOA or LODA). This would provide a lower-cost option as, with recent GPS developments, the certification path, especially outside the US, is the driving component of cost for this equipment. The non-certified equipment would still be capable of producing the NIC 6/SIL 1 output.		A sub-standard, for uncertified equipment, by definition would be a standard. The intent of the LASE is to provide a minimal standard equipment will need to meet to legally interoperate in the NAS.
295	NATS UK	Paragraph 3.a:	Could you clarify the intention of Class A devices and Class B devices please? Is it that LASE is made up of two components; Class A is the first component and is comprised of transponder, altitude source and ADS-B OUT functions. Class B is the second component, which is comprised of the GNSS position function? Table 18 in A1.2.5.10.1 suggests that LASE could just be just one of these components.		Text changed to clarify LASE classes

296	NATS UK	Paragraph A1.2.5.1	Paragraph A1.2.5.1 states 'The ADS-B OUT function must be 1090 Extended Squitter (ES) Out, to allow support of TCAS hybrid surveillance.' However, ED-221 (2013) indicates TCAS hybrid surveillance requires a NIC>=6 and a SIL=3. Class B equipment (section A1.2.5.4) although providing NIC>=6, only provides SIL=1 and as such would not according to ED-221 support TCAS hybrid surveillance		Text changed. LASE is designed so aircraft with hybrid surveillance will be able to detect and track LASE equipped aircraft as a Mode S target.
297	NATS UK	Paragraphs A1.2.5.3. and A2.2.5.3:	For information; NATS and the CAA are considering the RF footprint that LPAT is likely to have in areas of high traffic density, especially if every aircraft was equipped with a conspicuity device operating on 1090MHz. There is a perception that 1090MHz may become saturated in some areas if all GA devices operated at a minimum of 18.5 dBW (70 watts).		LASE is designed to reduce its RF footprint by not replying to most ground interrogations. Reduced power (less than 70 watts) was considered. This option was not pursued because; 1) neither time nor money were available to ensure TCAS systems, as designed now, would interoperate properly with lower powered surveillance systems. 2) Neither time nor money was available to determine if a reduced power system would increase or decrease RF congestion by making a surveillance unit that was 'quieter' and altering the link margin assumptions TCAS systems are built on. 3) ADS-B OUT capability was made a requirement on LASE equipment to take advantage of hybrid surveillance and thus reduce RF congestion

298	NATS UK	Paragraph A1.2.5.10.1 :	Request the meaning of these bits be changed to indicate that the GNSS source complies with A1.2.6 requirements rather than indicating the presence of a LASE system. It is acknowledged that current surveillance systems probably only process NIC, NACp and SIL for but there may be a benefit if the presence of a A1.2.6 chipset is uniquely identifiable		Indicating an aircraft is LASE equipped also indicates the position source or the transponder (or both) do not have a system capable of being used for separation services. An aircraft with an aviation grade GPS but lacking a fully qualified transponder would net the same result.
299	NATS UK	Paragraph A1.2.5.11:	The LASE requirements do not seem to provide a clear method for ground based systems to distinguish between users that have permission to enter controlled airspace (CAS) and those that do not. i.e. The likely default state of LASE will be to indicate the user does not have permission to enter CAS, therefore, any LASE user that is granted permission to access CAS is likely to result in the spurious generation of a CAS infringement warning in the ground surveillance system.		LASE equipment is not designed to reply to ATCRBS and Mode S ground interrogations. Bits 53 and 54 in Type Code 31 subtype 0 have been set to indicate the unit does not meet the minimum requirements of a surveillance system per 91.215 or 91.225. LASE equipment is not designed to be used in controlled airspace. Although LASE may provide an increased level of awareness to controllers, pilots flying with LASE will still need to request permission before entered controlled airspace.

300	NATS UK		Could we recommend that LASE provides an indication when the user is receiving ATC Services please? i.e. set Msg bit #61 and “ME” bit #29 of the Operational Mode dataset. If a toggle is used to activate this message, then the toggle should also activate an alternate Mode-A code, which should be preset before flight.		The capability to toggle between two different 4096 codes was added, see section A1.2.3.1.3.

301	NATS UK	Paragraph A1.2.6:	For information; FLARM has already demonstrated that GPS position integrity does not need to be assured to support “situational awareness” for General Aviation. FLARM provides a general warning that it is designed and built as a non-essential 'situation awareness only' unit to only support the pilot, and cannot always provide reliable warnings. (Section 12 in the FLARM installation manual). EASA has approved the installation of FLARM into certified airframes, therefore, ‘situational awareness’ devices that do not use a certified GPS chipset already have EASA approval. That said; NATS recognizes the merits of the GNSS Position Source Function Requirements in A1.2.6. If a 1090 ES-NT device (e.g. LPAT) had a GNSS source that complied with A1.2.6, would it be permissible in the US?		LPAT would not be allowed in US rule airspace.

302		Paragraph A2.2.6.3.1	Paragraph A2.2.6.3.1 states that a ‘representative antenna’ will be used in the screening tests. Different manufactures may opt for different antennas that can be mounted integrally or externally. Is it known how much the antenna design is likely to affect the GNSS performance? It is probably negligible, but we thought we would ask		Antenna installers must ensure they provide adequate coverage for the LASE system. Leeway is provided in the LASE TSO to allow for portable devices with a self-contained antenna to installed panel mount versions. Furthermore, antennas may be internally mounted in radar transparent aircraft or externally mounted.

303	421 Aviation Way Frederick, Maryland 21701 T. 301-695-2000 F. 301-695-2375 www.aopa.org June 29, 2014 Federal Aviation Administration Design, Manufacturing and Airworthiness Division Aircraft Certification Service System and Equipment Standards Branch, AIR-130 470 L'Enfant Plaza, SW, Suite 4102 Washington, DC 20024 Re: Draft Technical Standard Order, TSO-C199: Light Aircraft Surveillance Equipment Dear Sir or Madam, The Aircraft Owners and Pilots Association (AOPA), the world's largest aviation membership association, submits the following comments in response to the Federal Aviation Administration's (FAA) proposed draft Technical Standard Order, TSO-C199: Light Aircraft Surveillance Equipment. AOPA fully supports the FAA's intent to provide for light aircraft surveillance alternative (LASE), particularly for aircraft that are incapable of equipping in accordance with traditional transponder equipment, such as balloons, gliders, and aircraft without electrical systems. The LASE initiative is an opportunity to enhance the effectiveness of existing collision avoidance solutions by increasing the number of participating aircraft. Because cost has been and will continue to be the greatest barrier to equipage, the LASE solution must take into account the total equipage and installation cost to effect the greatest improvement in safety. AOPA urges the FAA to consider the "minimum' requirements that must be met for an LASE solution in light of the significant price sensitivity of potential LASE buyers. If the barriers to equip with LASE are set too high, aircraft owners will continue to operate without any surveillance equipment, or will elect to equip with alternative and less feature-rich equipment. For this reason, AOPA encourages the FAA to accept a *good* solution rather than fruitlessly pursue the *perfect* solution. An off-the-shelf global positioning system (GPS) chip could allow compliance for not just the glider or non-electrically equipped community, but also the VFR flyer. While AOPA recognizes that such a proposal would require an ADS-B Out rule change, the alternative is less desirable and would result in more non-participating aircraft who would choose another, non-ADS-B solution. We appreciate the opportunity to submit comments on this draft Technical Standard Order. Sincerely, Melissa K. Rudinger Vice President Government Affairs AIRCRAFT OWNERS AND PILOTS ASSOCIATION	The FAA recognizes the price sensitivity of potential buyers of this equipment and has carefully considered the requirements for users of this equipment to safely interoperate with other NAS users while minimizing costs to potential buyers, in order to encourage equipage on aircraft on which installation of this equipment is appropriate. We infer from the last paragraph of the letter that the commenter requests that the current ADS-B Out rule requirements be changed to allow commercial off-the-shelf (COTS) GPS equipment to be used to comply with the ADS-B Out rule for all VFR aircraft. In this regard, it must be emphasized that TABS (previously referred to as LASE) equipment is intended for use by aircraft that are incapable of equipping with ADS-B Out rule compliant equipment. As such, it is designed only for a limited intended function of increasing the aircraft's visibility to other suitably equipped aircraft. It is not designed to support provision of ATC separation services, and therefore does not meet the minimum standards for ADS-B Out rule compliance. The current ADS-B Out rule equipage requirements reflect what the FAA has determined necessary to safely support provision of ATC separation services. Therefore, at this time, the FAA does not plan to change the ADS-B Out rule to lower the current standards for equipage. Operators who choose not to equip with rule-compliant systems are not assured of being allowed to operate in ADS-B Out rule airspace after the ADS-B Out rule compliance date.

304	AFS-400		Recommended changing name of device to better describe capabilities. Changing name to Traffic Awareness Beacon System (TABS) to avoid possible misunderstandings of what the device can and cannot do.		Name changed to Traffic Awareness Beacon System (TABS)